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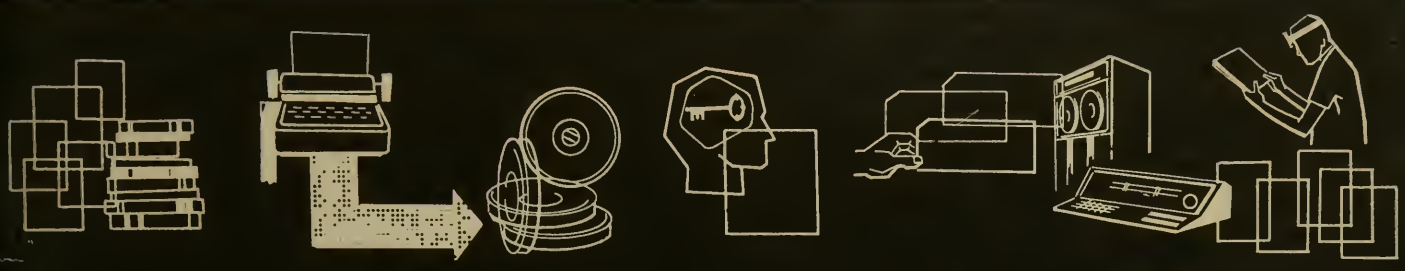
NATIONAL LIBRARY OF MEDICINE



The principles of MEDLARS

THE PRINCIPLES OF MEDLARS

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INTRODUCTION

The Medical Literature Analysis and Retrieval System (MEDLARS) is a mechanized bibliographic processing system which generates several different products and services, including:

1. The monthly publication Index Medicus and the annual Cumulated Index Medicus.

2. A number of published recurring bibliographies in specialized subject areas of medicine.

3. Retrospective searches of the literature on particular topics conducted in response to specific requests made by members of the biomedical community. These are known as demand searches.

4. Published literature searches on subjects of wide interest.

All of these products are generated from the same input by a digital computer and peripheral equipment.

This handbook

(a) describes MEDLARS in some detail, including its indexing procedures, vocabulary, searching strategies, products, and services;

(b) indicates the types of requests that are suitable for retrospective machine search in MEDLARS; and

(c) discusses the capabilities and limitations of the system.

The purpose of the handbook is to further your understanding of MEDLARS and thereby assist you in making the best possible use of its services.

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THE COVERAGE OF MEDLARS

Approximately 18,000 separate journals are currently received at the National Library of Medicine. Of these, about 2,300 are indexed into MEDLARS. These 2,300 have been selected as an optimum set of biomedical journals in all languages, to satisfy the interests of the majority of MEDLARS users. An effort is made to maintain a reasonable balance between the various subject areas.

In the selection of journals to be included in MEDLARS, the Library is advised by the Committee on Selection of Literature for MEDLARS, composed of leading physicians, medical librarians, and editors of medical journals.

This committee constantly evaluates new journals being published for possible inclusion in Index Medicus. It also evaluates the status of journals already being indexed and considers suggestions about candidates for inclusion in the system.

The List of Journals Indexed in Index Medicus (LJI) appears annually. It is published separately, but also appears in the annual Cumulated Index Medicus. In this list, the 2,300 titles indexed appear in four arrangements: by journal title, by journal-title abbreviation, by subject, and country of publication. A small additional group of unlisted journals, in special subject areas, are cited in MEDLARS products other than Index Medicus.

Most journals are indexed cover-to-cover. Original articles are indexed, as well as those editorials, biographies, and obituaries that have substantive content.

The designation selective is applied to those journals that are not exclusively medical. General scientific journals, such as Science and Nature, frequently contain biomedical articles. These journals are selectively indexed for their biomedical coverage only.

INDEXING FOR MEDLARS (Input Cycle)

As of March 1970 , the MEDLARS data base comprises over one million citations to biomedical articles input to the January 1964 and subsequent issues of the monthly Index Medicus. This data base is now growing at the rate of about 200,000 citations annually. The great majority of the citations are to articles from journals and other serial publications (e.g., annual reviews), but some refer to the technical report literature. Approximately 50% of the articles cited are written in languages other than English.

The indexing process involves the careful analysis of articles and description of the contents of each by the use of specific subject headings selected from a controlled list. High-quality articles are indexed with as many terms (subject headings) as are needed to fully describe the subject matter discussed. Although there is no ceiling placed on the number of headings, in practice, between 10 and 20 terms are assigned for these types of articles. They tend to be long, and are often research-oriented.

Shorter articles, and those which contain less substantive information, are usually indexed with enough subject headings to describe the principal points or highlights of the article.

The indexing is performed by a group of approximately 50 highly trained medical literature analysts, located at the National Library of Medicine and at MEDLARS Service Centers throughout the United States and abroad.

Figure 1 depicts, side by side, completed indexer data forms for two journal articles, one of which required more subject headings than the other to describe its content. Any given citation is published in Index Medicus under only a limited number of the subject headings assigned to it. Such headings, which are known as print terms or Index Medicus terms (IM terms), are those which, in the indexer's judgment, cover the principal points of the article. An X on the left of the data form under the IM column designates those IM terms under which the citation will be published in Index Medicus. The remaining headings assigned, non print terms or non Index Medicus terms (NIM terms), represent data or discussions, contained in the article, which are worth bringing out in the indexing but are not the central points of the article. All headings are recorded on the citation file (magnetic tape) and are used in machine search and retrieval operations.

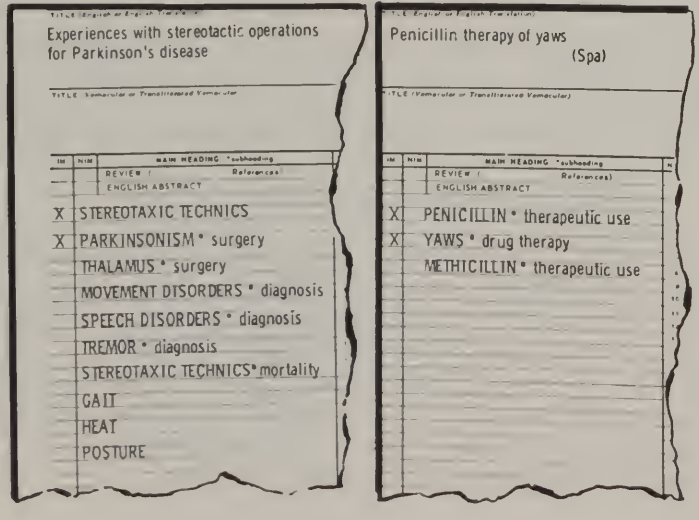


Figure 1

Medical Subject Headings

In describing the contents of an article, an analyst must use only those subject headings appearing in a list of accepted subject headings. This list, Medical Subject Headings, is published annually and is generally referred to as MeSH.

The published MeSH contains about 8,000 subject headings. All of the subject headings listed alphabetically in the first part of MeSH, (see figure 2) have been assigned to one or more of 14 broad subject categories, where semantically related terms are arranged in hierarchies in the categorized portion of MeSH. The 14 broad subject categories are as follows:

- A Anatomical Terms
- B Organisms
- C Diseases
- D Chemicals and Drugs
- E Analytical, Diagnostic, and Therapeutic Technics and Equipment
- F Psychiatry and Psychology
- G Biological Sciences
- H Physical Sciences
- I Anthropology, Education, Sociology, and Social Phenomena
- J Technology, Industry and Agriculture
- K Humanities
- L Communication, Library Science and Documentation
- M Named Groups of Persons
- N Health Care

These 14 categories are further subdivided into subcategories. For example, category C, Diseases, is subdivided into 17 subcategories, C1 through C17.

The published MeSH contains about 9,000 cross-references to assist the user. These cross-references also appear in the annual Cumulated Index Medicus. There are four types:

1. The see reference, which refers from a term not used to the appropriate synonymous or nearly synonymous term, as:

   Measles, German see RUBELLA

2. The see under reference, which refers from a specific term not used to the most appropriate generic term, as:

   Median Palatine Cyst see under NONODONTOGENIC CYSTS

3. The see also related reference, which links terms having closely related contexts (usually associating terms from different categories, such as an anatomical term and a disease term) as:

   MEDIAN NERVE see also related CARPAL TUNNEL SYNDROME

4. The see also specific reference, which links a generic term to one or more specific terms, as:

MUSHROOMS see also specific PSILOCYBINE

In addition, the printed MeSH contains reverse references to show terms referred from. For example,

CARPAL TUNNEL SYNDROME XR MEDIAN NERVE

which means that there is a see also related reference from MEDIAN NERVE to CARPAL TUNNEL SYNDROME. After each subject heading (also referred to as main heading) in MeSH appears the alphanumeric designation for the subcategory number (or numbers) to which the term belongs (see Figure 2). Thus, LIVER DISEASES is shown to belong to subcategory C4. Moving to C4 in the categorized section of MeSH, the analyst consults the term LIVER DISEASES and finds indented under it a list of specific liver diseases (Figure 3). Perhaps he will be able to find in this list a term that better describes the precise topic discussed in the article at hand, since the indexing rules require the analyst to describe each concept with the most specific term available in MeSH. If he selects HEPATITIS as the closest term available in this list, he can now look up this term, in the same subcategory, and find the terms that are subordinate to HEPATITIS (Figure 4). Perhaps he will make his final selection from this specific list.

Subheadings

In addition to the approximately 8,000 subject headings, MEDLARS makes use of about 60 subheadings. Subheadings are general-concept terms which enrich the vocabulary considerably. They are used only in combination with main headings to show a particular attribute or effect of the concept expressed by the main heading.

For example, a user of Index Medicus may want to locate articles on the liver, but from the anatomical point of view rather than that of physiology or metabolism. He does not need to look at all citations under LIVER but only at those under LIVER with the subheading "anatomy & histology."

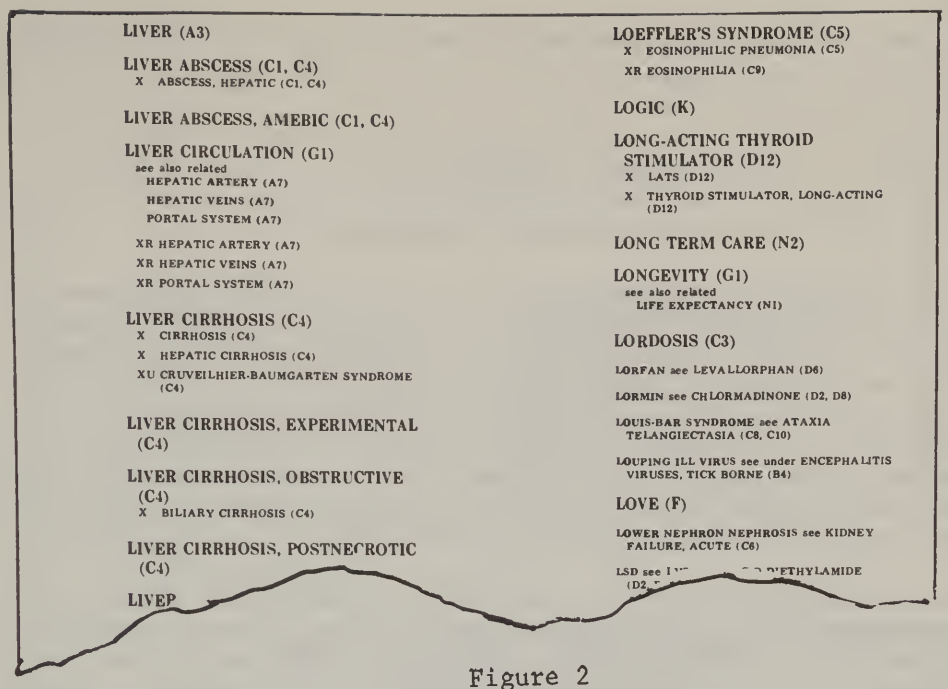


Figure 2

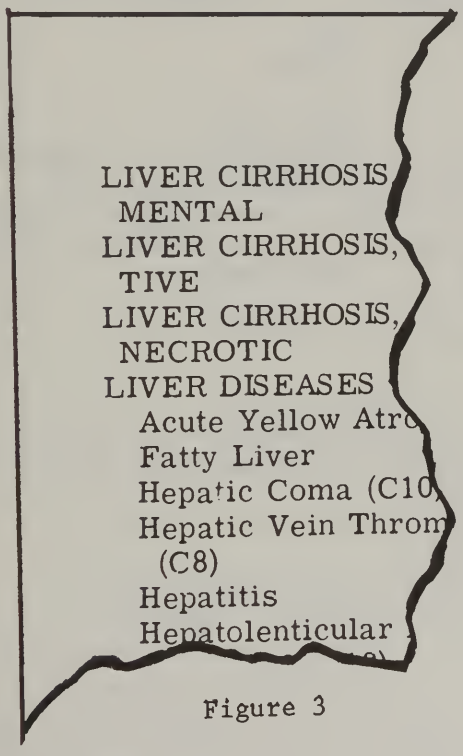


Figure 3

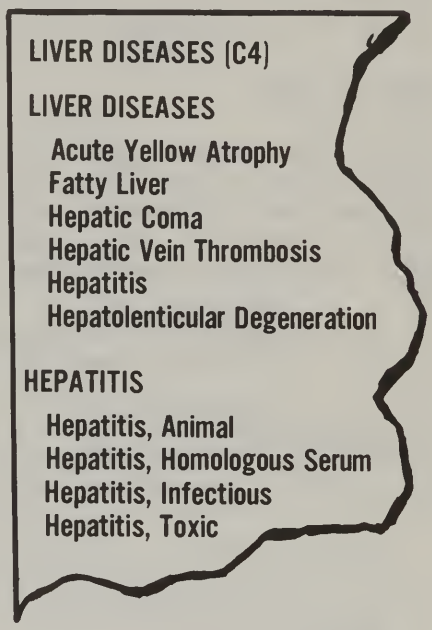


Figure 4

The pairing of a main heading with one of its desired facets is called a main heading/subheading combination. For convenience, subheadings have been assigned to one or more MeSH categories, and explicitly defined. The analyst may pair any given main heading only with a subheading which is "allowable" with the category to which the main heading belongs. Figure 5 shows a partial list of allowable combinations, and Figure 6 illustrates some correct and some incorrect combinations.

It is correct to speak about the utilization of nursing homes, or drug effects on bone development. But it is incorrect to pair "adverse effects" with divorce, for example, even if it seems acceptable, because "adverse effects" has been defined to be used with drugs, chemicals, biological or physical agents, or diagnostic or therapeutic technics causing unintended or undesirable reactions. The combination BONE DEVELOPMENT*chemically induced is incorrect because this subheading has been defined to mean that a disease has occurred as a result of using a drug.

Some subheadings have wide applicability and may be used with terms from a number of different categories. Such a subheading is "metabolism." It is correct to speak of the metabolism of the pancreas (category A), the metabolism of Salmonella typhosa (category B), metabolic aspects of pancreatitis (category C), or the metabolism of penicillin (category D).

In-House MeSH

The MEDLARS analysts have available to them a version of MeSH more complete and current than the version published annually. A specimen page is shown in Figure 7. This in-house MeSH is revised quarterly, and it contains about 1,000 more terms than the published MeSH. These additional terms are:

1. geographical headings, and
2. provisional headings.

The geographical headings are used to describe articles with epidemiological, political, sociological, or geographic interest. For instance, consider articles on:

Public Health in Ghana,
The Occurrence of a Case of Yaws in New York City,
The Cause of Illegal Abortions in Maryland, and
Social Security or Disability Coverage of Neuroses in France.

These articles are indexed under the most specific subject headings appropriate (PUBLIC HEALTH; YAWS; ABORTION, CRIMINAL; SOCIAL SECURITY), under which they will be found in Index Medicus. The appropriate geographic headings (GHANA; NEW YORK CITY; MARYLAND; FRANCE) are also indexed and stored for machine retrieval purposes.

INDEX MEDICUS SUBHEADINGS - 1970

Alphabetical List of 60 Subheadings

*abnormalities (A)
*administration & dosage (D)
*adverse effects (D,E,H,J)
*analysis (A,B,D,G,J)
*anatomy & histology (A,B)
*antagonists & inhibitors (D)
*biosynthesis (D)
*blood (C,D,F)
*blood supply (A)
*cerebrospinal fluid (C,D,F)
*chemical synthesis (D)
*chemically induced (C,F)
*classification (B,C,D,
*complications (C,F)
*instrumentation (E,F,G,H,J)
*isolation & purification (B,D)
*manpower (E,F,G,H,I,L,N)
*metabolism (A,B,C,D,F)
*microbiology (A,C)
*mortality (C,E,F)
*nursing (C,E,F)
*occurrence (C,F)
*path (B)

Figure 5

MAIN HEADING - SUBHEADING COMBINATIONS

VALID	INVALID
NURSING HOMES · utilization	FOOD · adverse effects
WATER SUPPLY · analysis	WATER · supply & distribution
BONE DEVELOPMENT · drug effects	BONE DEVELOPMENT · chemically induced

Figure 6

XS PAPAVER (B6)

OPOSSUMS (B2)
X DIDELPHIS (B2)

OPPENHEIM-ZIEHEN DISEASE see DYSTONIA MUSCULORUM DEFORMANS (C3, C10)

OPPENHEIM'S DISEASE see AMYOTONIA CONGENITA (C3, C10)

OPSONINS (D10, D12)
XR PHAGOCYTOSIS (G1)

OPTIC ATROPHY (C10, C11)

OPTIC CHIASM (A8)

OPTIC LOBE (A8)

OPTIC LOBE see under CORPORA QUADRIGEMINA (A8)

OREGON (Z1)

ORGABOLIN see ETHYLESTRENOL (D2, D8)

ORGAMETRIL see LYNESTRENOL (D2, D8)

ORGAN OF CORTI (A8, A9)
X CORTI'S ORGAN (A8, A9)
X SPIRAL ORGAN (A8, A9)

ORGAN PRESERVATION see under TISSUE PRESERVATION (E5)

ORGAN SPECIFICITY (G1)

ORGAN WEIGHT (E5)

ORGANIZATI

Figure 7

Provisional headings (shown underlined in the in-house MeSH) are terms available for indexing and machine searching which have not yet been approved as main headings for inclusion in Index Medicus. Whenever an analyst assigns a provisional heading, he may also assign an appropriate more general term under which the citation will be found in Index Medicus. For example, an analyst uses the provisional heading ACTINOSPECTACIN to describe an article on this specific drug. He also assigns the more generic term ANTIBIOTICS, ANTINEOPLASTIC, under which the citation will be printed in Index Medicus.

At present, there are approximately 600 provisional headings, which are periodically analyzed and evaluated in terms of volume of use. If used frequently enough they will become main headings. If little used, they are retained for further analysis or dropped as being superfluous.

The Indexing Operation

Every day, each MEDLARS analyst is assigned a pile of journals to be indexed. This assignment is in keeping with his experience or level of training, his language abilities, and his subject knowledge. Most analysts are able to read at least one foreign tongue, and many are able to index literature in four or five languages.

The high production demanded by MEDLARS (about 200,000 citations annually) precludes the possibility of an indexer reading every word of an article. With practice, one can index efficiently without the perusal of every single word of a text.

Analysts use a read/scan method based on the following instructions:

1. Read and understand the title.
2. Read the text down to the point at which the author states the purpose of his paper.
3. Scan the text, reading chapter headings, section headings, bold-face, italics, charts, plates, X-rays, etc.
4. Read every word of the summary.
5. Closely scan the abstract.
6. Scan the bibliographic references.

This stage of the indexing operation is the stage of conceptual analysis or content analysis (i.e., deciding what the article is about).

The next stage involves the transformation of this conceptual analysis into the most appropriate set of subject headings and subheadings, which are then recorded on the indexer's data form. This form is the official worksheet of the analyst. A data form accompanies each article indexed in each journal from the point of indexing until the indexed citation has been input to the computer.

A blank data form is shown in Figure 8. The upper portion is used to record a full bibliographic description of the article, and this forms the basis of the printed citation in Index Medicus or in a MEDLARS search printout. Some of the items--for example, author's name and title of the article--are picked up by the input typist from the article itself, whenever these items appear in standard form. Other items of data--for example, translation and transliteration of foreign titles--are always supplied on the data form by the analyst or by an indexing clerk. The language of a foreign article is always indicated. This appears as an abbreviation in Index Medicus and can be used as a search parameter in retrieval operations.

Check-Tags

Before describing the contents of the article in MeSH terms, the analyst turns his attention to a set of routine items that must be accounted for in the indexing of every article. These items are known as check-tags, and they are preprinted on the data form so that the analyst can check off all appropriate terms.

The analyst must account for the age of any person discussed in the article. He must also account for any experimental animals discussed. The names of the most common of these are preprinted for check-off. If a less common animal is involved, the analyst must select and record, elsewhere on the form, the most appropriate term from MeSH.

Any historical note in an article must also be accounted for by checking the appropriate period check-tag. These historical items must be indexed under the most appropriate main subject heading, with the subheading "history" added. A geographical term should also be used where appropriate, and the check-tags are used to identify the article as being an historical article (historical note on a subject) or an historical biography (historical note on a person). Biographical notes on living persons or persons immediately deceased are identified by checking the tag current biog-obit.

All articles must be checked to indicate whether the study is performed on humans or on animals. In vitro studies must be identified. So must the sex of the person or experimental animal. The tag case report is used for an article that is simply a single case study.

Studies describing controlled clinical research on human beings are identified by the check-tag clinical research, while studies of the comparative effects of two or more drugs, or two or more procedures or technics, are identified by the tag comparative study.

TA	ARTICLES	INDEXER	REVISER
			OPT PAGINATION

A – anonymous		PAGINATION
D – non-std. date		
P – non-std. pagination		

AUTHOR DATA (Last)

AUTHOR DATA (First)

TITLE (English or English Translation)

TITLE (Vernacular or Transliterated Vernacular)

IM	NIM	MAIN HEADING *subheading	NO.	ENTRY VOCABULARY
		REVIEW (References)	1	
		ENGLISH ABSTRACT	2	
			3	
			4	
			5	
			6	
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	
			16	
			17	INPUT TYPIST: DISREGARD TERMS BELOW
			18	
			19	
			20	
			21	
			22	
			23	
			24	
			25	

IM	NIM	CHECK TAGS	NIM	CHECK TAGS	NIM	CHECK TAGS	NIM	CHECK TAGS
		PREGNANCY		Cats		HISTORICAL BIOGRAPHY		CURRENT BIOG-OBIT
		INFANT, NEWBORN (to 1 month)		Cattle		HISTORICAL ARTICLE		ANIMAL EXPERIMENTS
		INFANT (1-23 months)		Chick Embryo		ANCIENT		HUMAN
		CHILD, PRESCHOOL (2-5 years)		Dogs		MEDIEVAL		MALE
		CHILD (6-12 years)		Frogs		MODERN		FEMALE
		ADOLESCENCE (13-18 years)		Guinea Pigs		15th CENT.		IN VITRO
		ADULT (19-44 years)		Hamsters		16th CENT.		CASE REPORT
		MIDDLE AGE (45-64 years)		Mice		17th CENT.		CLINICAL RESEARCH
		AGED (65- years)		Monkeys		18th CENT.		COMPARATIVE STUDY
				Rabbits		19th CENT.	CITATION NO.	
				Rats		20th CENT.		

NIH-1416
REV. 3-69

DATA FORM - INDEX MEDICUS

Figure 8

Four more items must be accounted for. Any well-documented survey of the recent literature on a specific subject is checked as review. The analyst also supplies the exact number of references. Review articles appear under their appropriate specific subject headings in Index Medicus and the Cumulated Index Medicus. They are also brought together in the review sections of these publications and are published separately as the Monthly Bibliography of Medical Reviews.

The terms PREGNANCY and INFANT, NEWBORN must be checked whenever an article discusses a pregnant human or pregnant animal, or when a newborn infant is discussed. The citation to an article on normal pregnancy or the normal newborn infant must be printed under the heading PREGNANCY or INFANT, NEWBORN in Index Medicus. If the article deals with complications of pregnancy or diseases of the newborn, the headings PREGNANCY or INFANT, NEWBORN are used for storage in the computer. For Index Medicus, the indexer also assigns the headings PREGNANCY COMPLICATIONS or INFANT, NEWBORN, DISEASES.

Coordinate Indexing

The remaining space on the data form is reserved for the description of the article in terms of Medical Subject Headings. The analyst types all of the headings, with subheadings whenever appropriate, necessary to describe the content of the article.

MEDLARS indexing is coordinate indexing. This means that complex concepts may be expressed by combinations or coordinations of two or more terms. We have already seen how we can combine a main heading with a subheading to express a more complex (specific) concept, as HEPATITIS*prevention & control. We can also express a complex concept by the joint use of two or more main headings. For example, an article discussing "community health services under Regional Medical Programs" would be indexed with the main headings COMMUNITY HEALTH SERVICES and REGIONAL MEDICAL PROGRAMS, both to be printed in Index Medicus.

An article on "statistics on nursing homes" would be also indexed with two main headings: NURSING HOMES and STATISTICS. This citation would be found in Index Medicus under NURSING HOMES. STATISTICS would be stored for future machine retrieval of articles indexed under both NURSING HOMES and STATISTICS.

Coordination may also be achieved by the joint use of a main heading and a check-tag. Thus, "hepatitis in females" may be expressed by assigning the term HEPATITIS and checking the tag FEMALE.

Some coordination already exists in the characteristics of certain main headings themselves. Thus, LIVER GLYCOGEN represents a pre-coordination of the concept "liver" and the concept "glycogen." Likewise, DIABETES MELLITUS, JUVENILE is a pre-coordination of the concept "diabetes mellitus" and the concept "child."

A cardinal rule of indexing in MEDLARS is that a topic is always indexed under the most specific available term. An article on sunburn is indexed under SUNBURN and not under BURNS, an article on eye burns under EYE BURNS and not under BURNS. An article on friction burns, however, would be indexed under BURNS because no specific term for friction burns exists in MeSH.

Indexing Revision

The work of trainees and junior indexers is subjected to a checking operation conducted by a fully experienced indexer, known as a "reviser." The reviser rapidly scans the bibliographic description and then concentrates on the assigned subject headings, asking the following questions:

Do the main headings reflect the true content of the article?

Do the Index Medicus (print) headings cover the central points of the article?

Are the headings spelled correctly, in exactly the form appearing in MeSH?

Are the correct subheadings used?

Are all necessary check-tags present and have they been used correctly?

Are the relationships expressed correct? Did disease X lead to Y or did Y cause X?

Are the headings at the correct level of specificity for the article?

The Analyst's Reference Tools

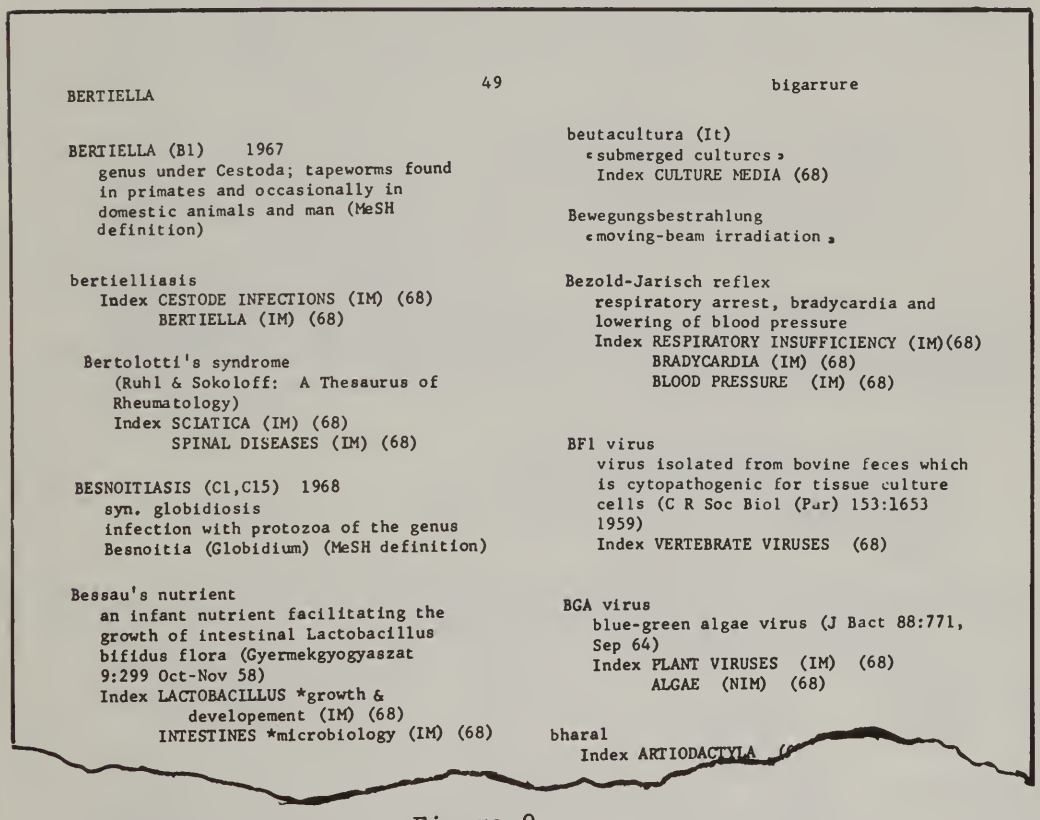
The MEDLARS indexer is taught that the world's best authority for his indexing of an article is the text of the article itself. Beyond the article, however, he makes use of a number of basic tools and references.

In addition to MeSH, the analyst has on his desk a copy of the Indexing Manual. This is a 500-page volume of indexing policy and indexing interpretation revised, by monthly interim supplements, to conform with additions and changes in MeSH itself.

The Integrated Authority File, a sample of which appears in Figure 9, is a large MEDLARS entry vocabulary. It contains medical terms and expressions and foreign words and phrases occurring in the literature, showing how each should be indexed using the controlled vocabulary of Medical Subject Headings. It also includes provisional headings and scope notes that show how MeSH terms are defined and applied.

Senior indexers have prepared various other compilations of indexing instructions relating to particular subject areas, such as respiration physiology, genetics, and steroids.

The official dictionary used by MEDLARS analysts is Dorland's Medical Dictionary. In indexing tumors, however, the indexer routinely checks each term used by an author against the American Cancer Society's Manual of Tumor Nomenclature and Coding. Standard texts on bacteria, viruses, enzymes, rheumatic diseases, hematology, cardiology, ophthalmology, and other subjects are available to the MEDLARS analyst for instant reference. For example, he uses the Index Bergeyana for bacteria and Andrews' Viruses of Vertebrates for viruses.



BERTIELLA 49 bigarrure

BERTIELLA (Bl) 1967
genus under Cestoda; tapeworms found in primates and occasionally in domestic animals and man (MeSH definition)

bertielliasis
Index CESTODE INFECTIONS (IM) (68)
BERTIELLA (IM) (68)

Bertolotti's syndrome
(Ruhl & Sokoloff: A Thesaurus of Rheumatology)
Index SCIATICA (IM) (68)
SPINAL DISEASES (IM) (68)

BESNOITIASIS (C1,C15) 1968
syn. globidiosis
infection with protozoa of the genus Besnoitia (Globidium) (MeSH definition)

Bessau's nutrient
an infant nutrient facilitating the growth of intestinal Lactobacillus bifidus flora (Gyermekgyogyaszat 9:299 Oct-Nov 58)
Index LACTOBACILLUS *growth & developement (IM) (68)
INTESTINES *microbiology (IM) (68)

beutacultura (It)
«submerged cultures»
Index CULTURE MEDIA (68)

Bewegungsbestrahlung
«moving-beam irradiation»

Bezold-Jarisch reflex
respiratory arrest, bradycardia and lowering of blood pressure
Index RESPIRATORY INSUFFICIENCY (IM)(68)
BRADYCARDIA (IM) (68)
BLOOD PRESSURE (IM) (68)

BFl virus
virus isolated from bovine feces which is cytopathogenic for tissue culture cells (C R Soc Biol (Par) 153:1653 1959)
Index VERTEBRATE VIRUSES (68)

BGA virus
blue-green algae virus (J Bact 88:771, Sep 64)
Index PLANT VIRUSES (IM) (68)
ALGAE (NIM) (68)

bharal
Index ARTIODACTYLA

Figure 9

An Example of the Indexing Procedure

To illustrate the MEDLARS indexing process further, it may be useful to look over the shoulder of an indexer, as it were, to see the steps involved in subject-indexing a typical article. The sample article is entitled "Positive Sputum Cytologic Tests for Five Years Before Specific Detection of Bronchial Carcinoma."

After reading key portions of the article, and scanning the remaining text, the indexer decides that the article deals primarily with the diagnosis of pulmonary and bronchial neoplasms by means of cytological tests of the sputum. He therefore assigns the following main heading/subheading combinations:

X SPUTUM*cytology
X CARCINOMA, BRONCHOGENIC*diagnosis
X BRONCHIAL NEOPLASMS*diagnosis
X LUNG NEOPLASMS*diagnosis

indicating by the X that these are print terms, representing headings under which the citation should be printed in Index Medicus. This is also a study, by cytological methods, of the pathology of various types of tumors, and this leads him to assign the additional terms:

BRONCHIAL NEOPLASMS*pathology
CARCINOMA, EPIDERMOID*pathology
CARCINOMA, BRONCHOGENIC*pathology
ADENOCARCINOMA*pathology
CYTODIAGNOSIS

The patient discussed in the article, a 72-year-old man, was subjected to various diagnostic procedures, including radiography, bronchoscopy, and biopsy. The following terms were therefore assigned:

BRONCHIAL NEOPLASMS*radiography
CARCINOMA, BRONCHOGENIC*radiography
BRONCHOSCOPY
BIOPSY

and the following check-tags were marked:

AGED
HUMAN
MALE

In addition, the provisional heading TIME FACTORS was assigned to account for the time period (five years) over which the cytologic tests were conducted. The completed data form is shown as Figure 10.

You have now completed a broad outline course in MEDLARS indexing. In a later section, you will learn how the results of this indexing are used in the searching and retrieval of medical literature.

JTA:	ARTICLES	INDEXER	REVISER

A - anonymous		PAGINATION	OPT. PAGINATION
D - non-std. date		318-24	
P - non-std. paginotion			

AUTHOR DATA *(print)*

AUTHOR DATA *(sort)*

TITLE *(English or English Translation)*

TITLE *(Vernacular or Transliterated Vernacular)*

IM	NIM	MAIN HEADING *subheading	NO.	ENTRY VOCABULARY
		REVIEW (References)	1	
		ENGLISH ABSTRACT	2	
			3	
X		SPUTUM *cytology	4	
X		CARCINOMA, BRONCHOGENIC *diagnosis	5	
		BRONCHIAL NEOPLASMS *radiography	6	
X		BRONCHIAL NEOPLASMS *diagnosis	7	
		CARCINOMA, BRONCHOGENIC *radiography	8	
		CYTODIAGNOSIS	9	
		BRONCHIAL NEOPLASMS *pathology	10	
		BRONCHOSCOPY	11	
		CARCINOMA, EPIDERMOID *pathology	12	
X		LUNG NEOPLASMS *diagnosis	13	
		ADENOCARCINOMA *pathology	14	
		CARCINOMA, BRONCHOGENIC *pathology	15	
		BIOPSY	16	
			17	INPUT TYPIST: DISREGARD TERMS BELOW
		TIME FACTORS	18	
			19	
			20	
			21	
			22	
			23	
			24	
			25	

IM	NIM	CHECK TAGS	NIM	CHECK TAGS	NIM	CHECK TAGS	NIM	CHECK TAGS
		PREGNANCY		CATS		HISTORICAL BIOGRAPHY		CURRENT BIO-OBIT
		INFANT, NEWBORN (to 1 month)		CATTLE		HISTORICAL ARTICLE		ANIMAL EXPERIMENTS
		INFANT (1-23 months)		CHICK EMBRYO		ANCIENT	X	HUMAN
		CHILD, PRESCHOOL (2-5 years)		DOGS		MEDIEVAL	X	MALE
		CHILD (6-12 years)		FROGS		MODERN		FEMALE
		ADOLESCENCE (13-18 years)		GUINEA PIGS		15th CENT.		IN VITRO
		ADULT (19-44 years)		HAMSTERS		16th CENT.		CASE REPORT
		MIDDLE AGE (45-64 years)		MICE		17th CENT.		CLINICAL RESEARCH
	X	AGED (65- years)		MONKEYS		18th CENT.		COMPARATIVE STUDY
				RABBITS		19th CENT.	CITATION NO.	
				RATS		20th CENT.		

NIH-1416
REV. 3-69

DATA FORM - INDEX MEDICUS
FIGURE 10

GPO 1969 O—350-778

The monthly output of completed indexer data forms (about 20,000 monthly in 1970) is used as input to procedures which generate the machine-readable data base. The subject headings assigned to a particular journal article, together with the full bibliographic citation for this article, are put into machine-readable form by input typists using paper tape typewriters. These machines simultaneously produce a punched paper tape and a proof paper copy. After proofreading, the input paper tapes and correction tapes go through a computer input procedure which transfers the input data for each article (bibliographic citation plus index terms) to magnetic tape. This cycle is depicted graphically in Figure 11.

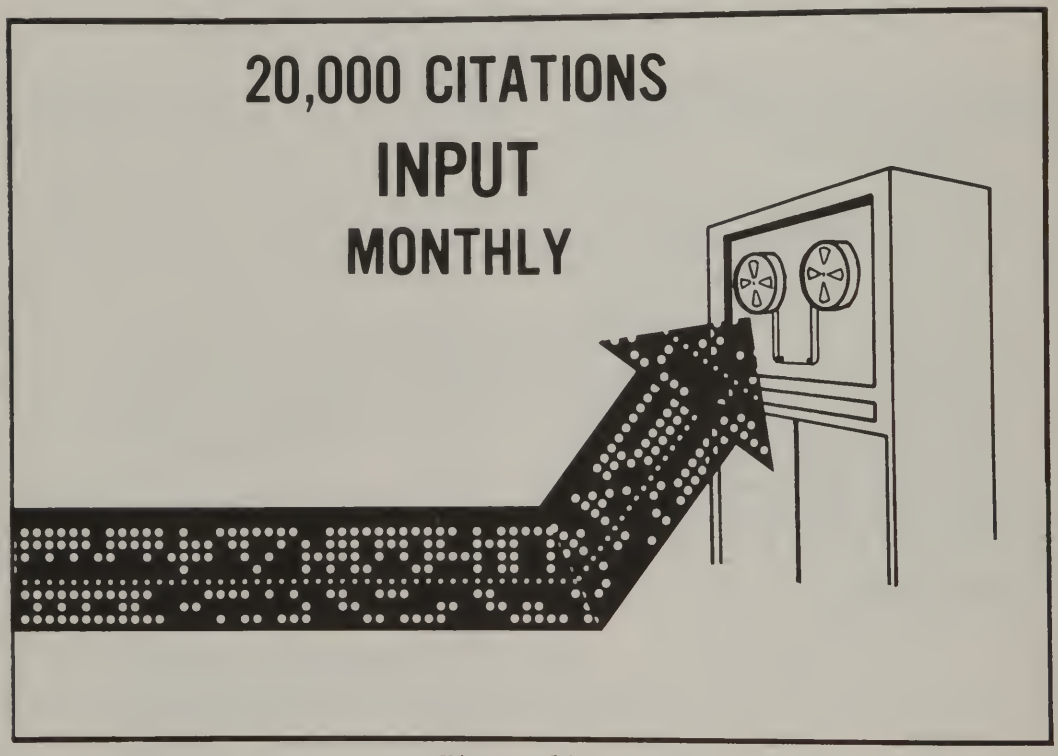


Figure 11

Production of Index Medicus (Publication Cycle)

The magnetic tapes produced by these input procedures contain unit records for each citation, arranged sequentially in order of accession (i.e., in citation-number order). For each citation, the following data are recorded: citation number, author and title of article (including English translation of foreign titles), journal reference, language abbreviation for languages other than English, all the subject headings assigned by the indexer, and other pertinent information such as place of publication. For review articles, the number of references is also recorded. The contents of the tape are shown in simplified form in Figure 12.

The magnetic tape containing one month's input of indexed citations is processed to generate the next monthly issue of Index Medicus. The computer programs used to generate this publication are rather complex (see Figure 13). Essentially, however, they accomplish the following tasks:

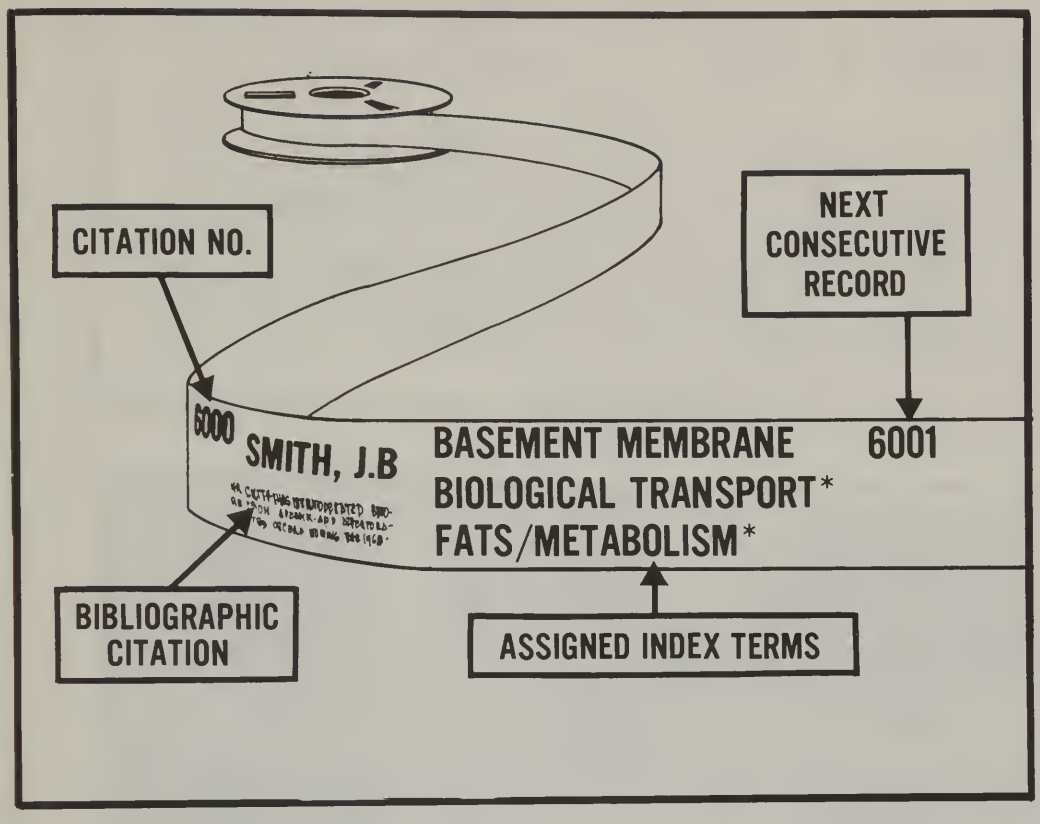


Figure 12

1. Replication and Sorting. A citation is replicated and sorted under all the headings under which it is to be printed (i.e., all the headings marked as print headings by the indexer, plus author headings and cross-references for the author section.)

2. Formatting. A series of programs transforms each citation into standard print formats, arranges the citations in the columnar form in which they will appear in the final publication, and handles such additional items as page headings, column headings, and page numbers.

3. Photocomposing. The correctly formatted tapes are processed by a photocomposing machine known as GRACE (Graphic Arts Composing Equipment). The final product of GRACE is a roll of exposed paper, each roll containing about 120 pages for publication (Figure 13).

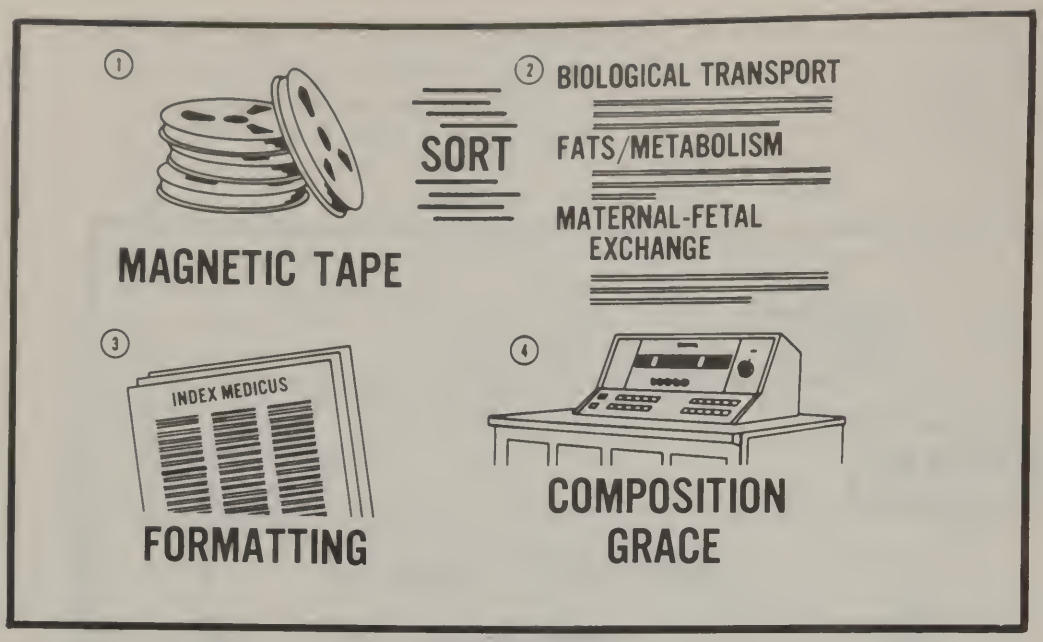


Figure 13

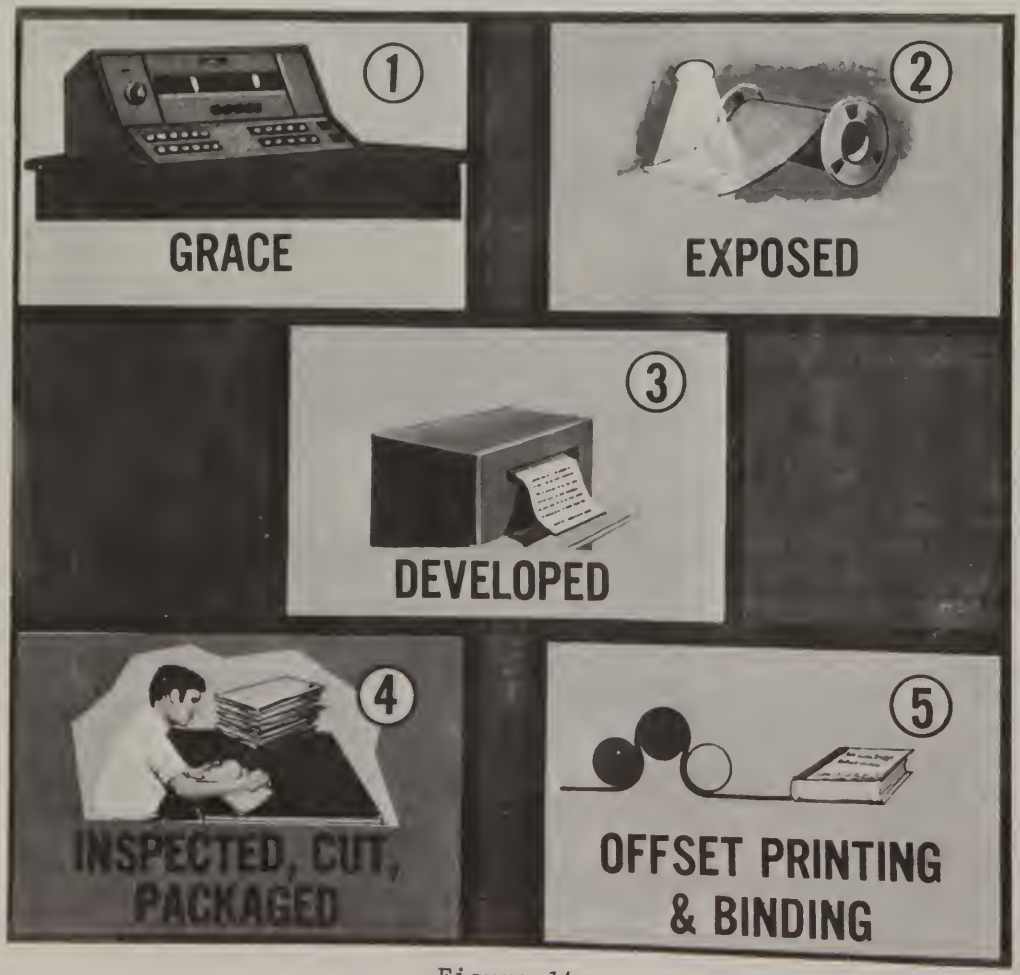
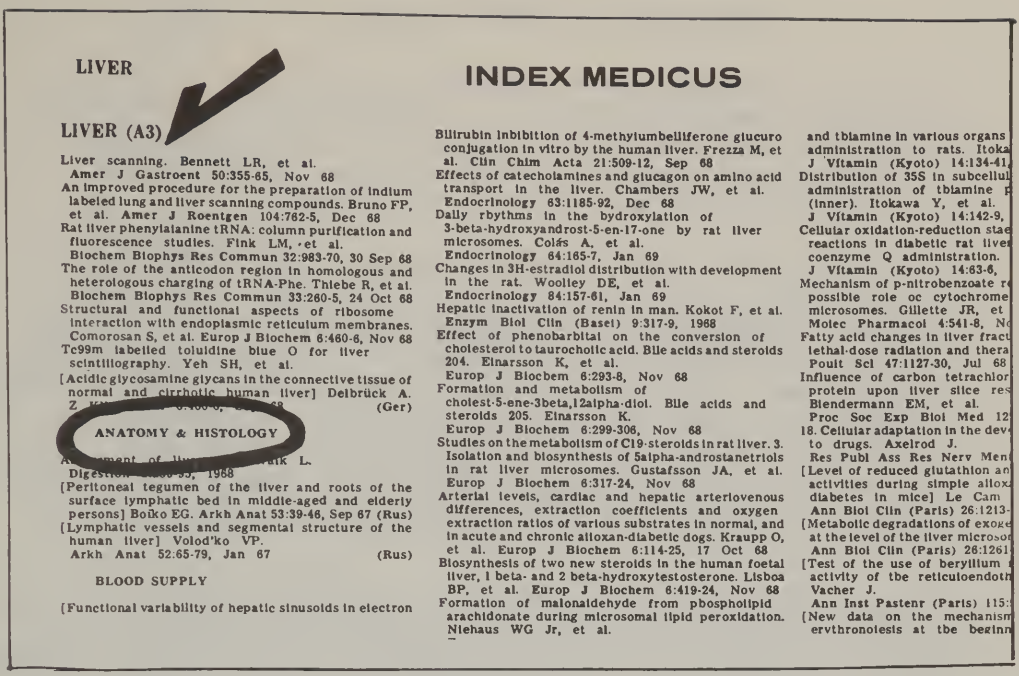


Figure 14



LIVER

LIVER (A3)

Liver scanning. Bennett LR, et al.
Amer J Gastroent 50:355-65, Nov 68
An improved procedure for the preparation of indium labeled lung and liver scanning compounds. Bruno FP, et al. Amer J Roentgen 104:762-5, Dec 68
Rat liver phenylalanine tRNA: column purification and fluorescence studies. Fink LM, et al.
Biochem Biophys Res Commun 32:983-70, 30 Sep 68
The role of the anticodon region in homologous and heterologous charging of tRNA-Phe. Thiebe R, et al.
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Structural and functional aspects of ribosome interaction with endoplasmic reticulum membranes. Comorosan S, et al. Europ J Biochem 6:460-6, Nov 68
Tc99m labelled toluidine blue O for liver scintillography. Yeh SH, et al.
[Acidic glycosamine glycans in the connective tissue of normal and cirrhotic human liver] Delbrück A. Z [illegible] (Ger)

ANATOMY & HISTOLOGY

[illegible] Lik L.
Digestion [illegible] 1968
[Peritoneal tegumen of the liver and roots of the surface lymphatic bed in middle-aged and elderly persons] Boĭko EG. Arkh Anat 53:39-46, Sep 67 (Rus)
[Lymphatic vessels and segmental structure of the human liver] Volod'ko VP.
Arkh Anat 52:65-79, Jan 67 (Rus)

BLOOD SUPPLY

[Functional variability of hepatic sinusoids in electron

INDEX MEDICUS

Bilirubin inhibition of 4-methylumbelliferone glucuro conjugation in vitro by the human liver. Frezza M, et al. Clin Chim Acta 21:509-12, Sep 68
Effects of catecholamines and glucagon on amino acid transport in the liver. Chambers JW, et al.
Endocrinology 83:1185-92, Dec 68
Daily rhythms in the hydroxylation of 3-beta-hydroxyandrost-5-en-17-one by rat liver microsomes. Colás A, et al.
Endocrinology 84:165-7, Jan 69
Changes in 3H-estradiol distribution with development in the rat. Woolley DE, et al.
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Enzym Biol Clin (Basel) 9:317-9, 1968
Effect of phenobarbital on the conversion of cholesterol to taurocholic acid. Bile acids and steroids 204. Einarsson K, et al.
Europ J Biochem 6:293-8, Nov 68
Formation and metabolism of cholest-5-ene-3beta,12alpha-diol. Bile acids and steroids 205. Einarsson K.
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Studies on the metabolism of C19-steroids in rat liver. 3. Isolation and biosynthesis of 5alpha-androstanetriols in rat liver microsomes. Gustafsson JA, et al.
Europ J Biochem 6:317-24, Nov 68
Arterial levels, cardiac and hepatic arteriovenous differences, extraction coefficients and oxygen extraction ratios of various substrates in normal, and in acute and chronic alloxan-diabetic dogs. Kraupp O, et al. Europ J Biochem 6:114-25, 17 Oct 68
Biosynthesis of two new steroids in the human foetal liver, 1 beta- and 2 beta-hydroxytestosterone. Lisboa BP, et al. Europ J Biochem 6:419-24, Nov 68
Formation of malonaldehyde from phospholipid arachidonate during microsomal lipid peroxidation. Niehaus WG Jr, et al.

and thiamine in various organs administration to rats. Itoka
J Vitamin (Kyoto) 14:134-41,
Distribution of 35S in subcellul administration of thiamine p (inner). Itokawa Y, et al.
J Vitamin (Kyoto) 14:142-9,
Cellular oxidation-reduction stae reactions in diabetic rat liver coenzyme Q administration.
J Vitamin (Kyoto) 14:63-6,
Mechanism of p-nitrobenzoate re possible role oc cytochrome microsomes. Gillette JR, et
Molec Pharmacol 4:541-8, No
Fatty acid changes in liver fract lethal-dose radiation and thera
Pouit Sci 47:1127-30, Jul 68
Influence of carbon tetrachlor protein upon liver slice res Biendermann EM, et al.
Proc Soc Exp Biol Med 12
18. Cellular adaptation in the dev to drugs. Axelrod J.
Res Publ Ass Res Nerv Men
[Level of reduced glutathion an activities during simple alloxdiabetes in mice] Le Cam
Ann Biol Clin (Paris) 26:1213-
[Metabolic degradations of exoge at the level of the liver microso
Ann Biol Clin (Paris) 26:1261
[Test of the use of beryllium activity of the reticuloendoth
Vacher J.
Ann Inst Pasteur (Paris) 115:
[New data on the mechanism erythronoiesis at the beginn

Figure 15

The exposed paper is developed by an automatic processor. The developed paper is inspected, cut into page-size sheets, and packaged for delivery to a commercial printer. Offset printing and binding complete the publication cycle (Figure 14). Figure 15 is a sample page from a monthly issue of Index Medicus. Note how the subheadings, as assigned by the indexers, are used to subdivide the entries under a main subject heading. After paper-tape input, all sorting, formatting, and composing functions are computer-controlled.

Identical procedures are followed in the production of the annual Cumulated Index Medicus, although processing time for the annual publication is obviously much greater.

CONDUCTING THE DEMAND SEARCH

Retrieval in MEDLARS, as in any other information system, is essentially a matching process. A request for literature on a particular topic is matched against the file of citations to biomedical articles that have been input to the system. When a match occurs, an article is retrieved.

To facilitate the match between requests and documents, both are described by means of terms selected from a controlled vocabulary, Medical Subject Headings (MeSH). In the indexing operation, the subject matter of journal articles is described in MeSH terms. Similarly, a search formulation (search strategy) in MEDLARS is a description of an information requirement (as reflected in a request made to the system) in MeSH terms. The data processing capabilities of MEDLARS are used to match search formulations against the file of document descriptions (i.e., indexed citations).

A simple example of a "retrieval" is presented in Table I. The requester is interested in the crossing of lipids through the placental barrier. A simplified search strategy for this request is given. This strategy states that an article should be retrieved only if it was indexed under the term MATERNAL-FETAL EXCHANGE and under a term indicating lipids. This formulation, when matched against the file of indexed articles, retrieves a citation to the article represented (along, presumably, with citations to other articles) which was indexed under MATERNAL-FETAL EXCHANGE and also under FATS, a term subordinate to LIPIDS in the MeSH vocabulary.

The MEDLARS storage and retrieval operations are represented by a simple flow diagram in Figure 16. Note that the computer does nothing more than match search formulations against indexed citations. It has very little direct influence on the success or failure of a search. The degree of success of a MEDLARS search is determined largely by the intellectual efforts of MEDLARS analysts in indexing, searching, and vocabulary development.

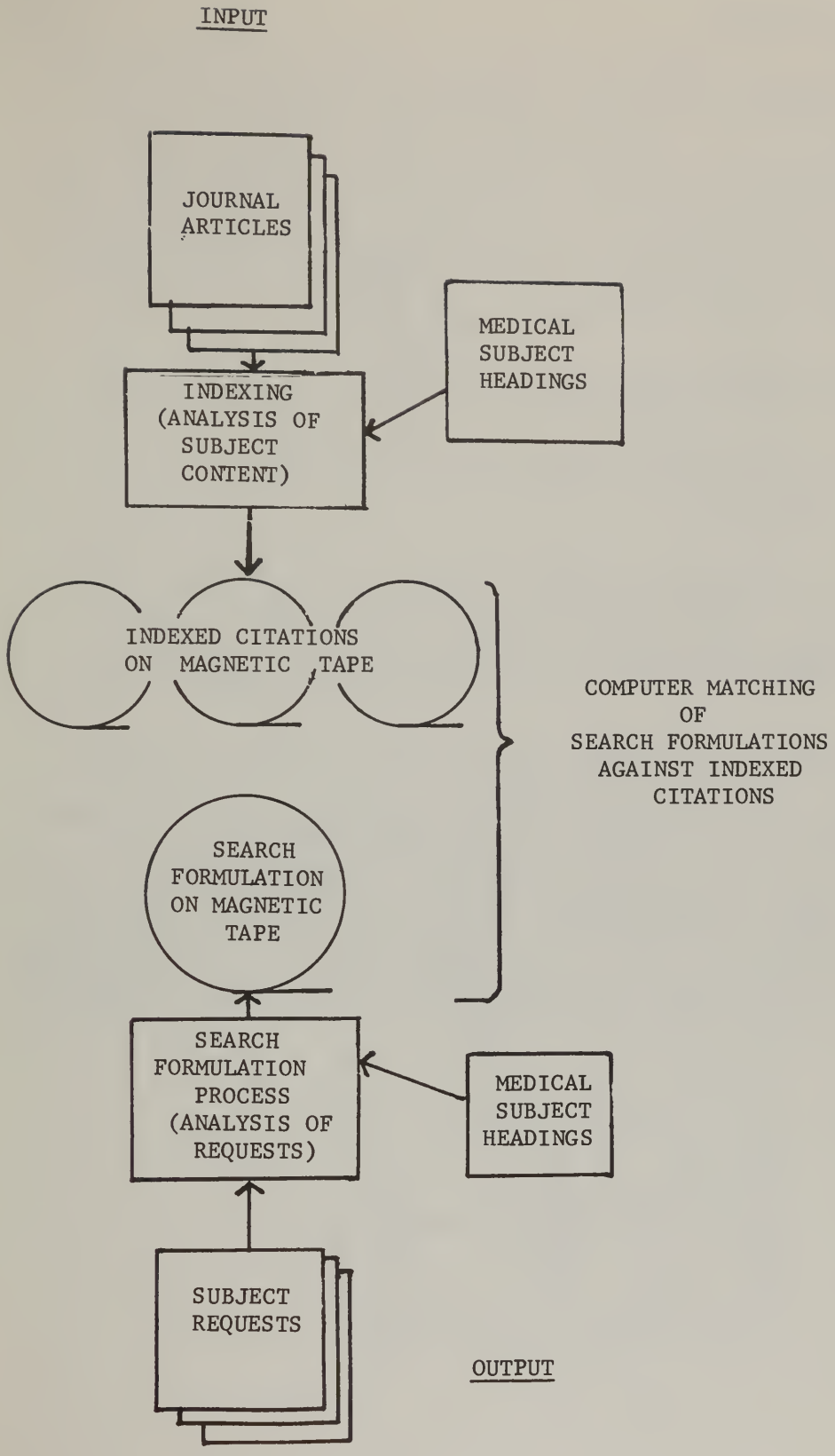

INPUT
JOURNAL ARTICLES
MEDICAL SUBJECT HEADINGS
INDEXING (ANALYSIS OF SUBJECT CONTENT)
INDEXED CITATIONS ON MAGNETIC TAPE
COMPUTER MATCHING OF SEARCH FORMULATIONS AGAINST INDEXED CITATIONS
SEARCH FORMULATION ON MAGNETIC TAPE
SEARCH FORMULATION PROCESS (ANALYSIS OF REQUESTS)
MEDICAL SUBJECT HEADINGS
SUBJECT REQUESTS
OUTPUT

FIGURE 16

Request Analysis

A MEDLARS search request asks for the conduct of a retrospective search, through the indexed citations in the MEDLARS data base, in order to retrieve citations that deal with a particular item of subject matter. These requests are made by medical educators, practitioners, researchers, and other health professionals. Searches are requested for a variety of purposes: for example, to determine the state of research in a particular field, to assist in the preparation of a review article, or to help solve a clinical problem. Approximately 12,000 MEDLARS searches were completed in the United States in F.Y. 1969.

In indexing an article for input to MEDLARS, the indexer goes through a two-stage process:

1. deciding what the article is about, and
2. describing the contents of the article by means of MeSH terms.

A search analyst goes through the same two-stage process. First, he must decide what the request is about (i.e., what kinds of articles the requester really wants to see). Second, he must translate his interpretation of the request into a search statement, in MeSH terms, that can be processed against the citation file.

In the analysis of a request, it is logical to begin by breaking the request into its various aspects, or facets. For example, consider a search for literature on the subject of renal amyloidosis. This request has two facets: (1) the organ facet (kidney) and (2) the disease facet (amyloidosis). The requester is not interested in all articles on the kidney, and he is not interested in all articles on amyloidosis. He is interested only in articles that discuss both facets of his request, i.e., kidney and amyloidosis, and which presumably deal with renal amyloidosis. This relationship between the two facets may conveniently be represented by a diagram of overlapping circles, as in Figure 17.

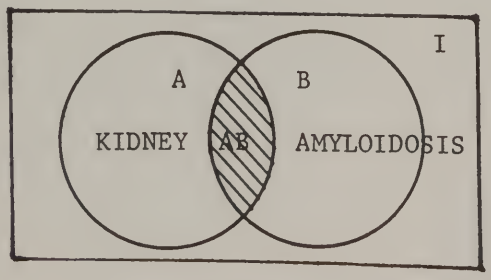


FIGURE 17

TABLE I

DOCUMENT

Electron microscopic observations on transference of fat through the human placenta.

INDEXING

BASEMENT MEMBRANE
X BIOLOGICAL TRANSPORT
X FATS*metabolism
X MATERNAL - FETAL EXCHANGE
MICROSCOPY, ELECTRON
PINOCYTOSIS
PLACENTA*physiology
PREGNANCY
HUMAN

REQUEST

Crossing of lipids through the placental barrier. Normal lipid levels in placenta, fetus or newborn infant.

SEARCH FORMULATION

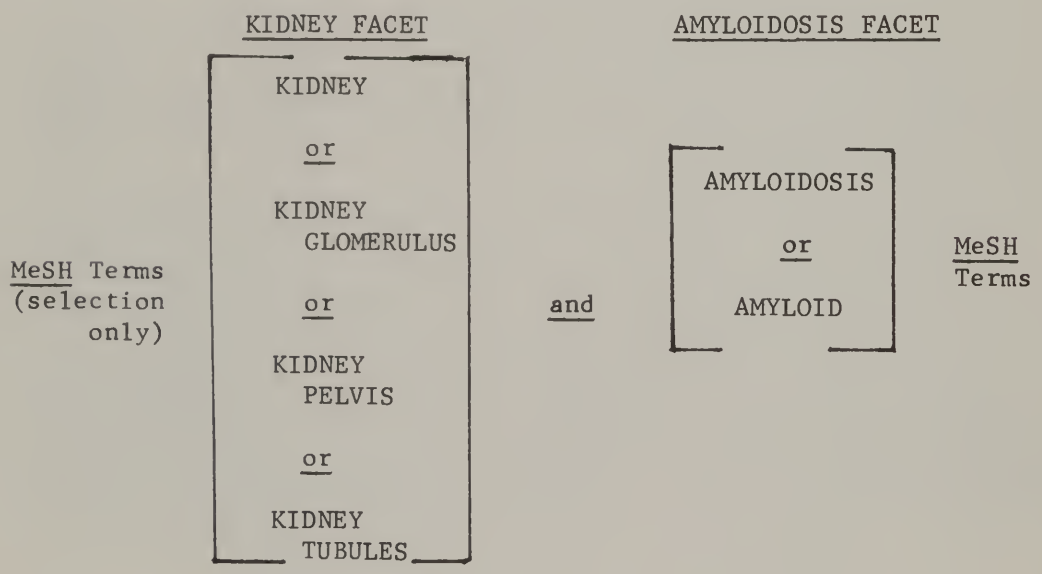
LIPIDS or FATS or any other MESH term indicating lipids

and

MATERNAL-FETAL EXCHANGE

The rectangle I represents the entire MEDLARS collection. For this particular request we are interested in two classes of articles: the class (A) dealing with the kidney and the class (B) dealing with amyloidosis. Specifically, we are interested only in the intersection or overlap of these two classes, namely, the subclass AB that deals both with kidney and with amyloidosis. The overlap of classes is also known as the union, product, or intersection of these classes. The relationship between these classes is an AND relationship. In the above example, both classes must be present in order for an article to be of interest (i.e., KIDNEY and AMYLOIDOSIS).

Having conceptually analyzed a request into its component facets, the next step involves translating this conceptual analysis into MeSH terms. There is no single MeSH term covering "renal amyloidosis." We must therefore search for articles that are indexed under terms indicating kidney and under terms indicating amyloidosis. We make use of MeSH to arrive at lists of terms indicating, on the one hand, kidney and, on the other, amyloidosis as follows:



Note that we will accept any of the selected terms indicating kidney and any term indicating amyloidosis. Thus, the terms in the kidney facet are all alternatives (substitutes) for one another. The relationship between these terms is therefore an OR relationship. We will accept KIDNEY or KIDNEY GLOMERULUS or KIDNEY PELVIS or KIDNEY TUBULES. A list of alternative terms (i.e., terms in an OR relationship) is called a sum of these terms.

Summations of classes can also be represented diagrammatically. In Figure 18, for example, we depict the sum of the class "amyloid" and the class "amyloidosis". Thus, in a MEDLARS search strategy,

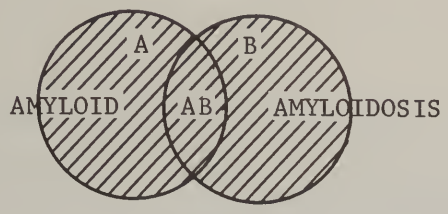


FIGURE 18

when we say AMYLOID or AMYLOIDOSIS, we are specifying that we will accept any citation indexed under the term AMYLOID (Class A in Figure 18) or any citation indexed under AMYLOIDOSIS (Class B) or any citation indexed under both the term AMYLOID and the term AMYLOIDOSIS (AB).

A Simple Search Formulation

Above we have graphically represented a very simple search formulation for a request on renal amyloidosis. By giving each term in this strategy a unique identifying number, and by using symbols that are recognized by the MEDLARS computer, we can reduce this strategy to a simple algebraic search equation. Consider the following:

M_1 KIDNEY

M_2 KIDNEY GLOMERULUS

M_3 KIDNEY PELVIS

M_4 KIDNEY TUBULES

M_8 AMYLOID

M_9 AMYLOIDOSIS

In our search equation we want to specify that we will accept any article indexed under any one of the kidney terms, M_1 - M_4, and also under one of the amyloidosis terms, M_8 - M_9. That is, we want the intersection or product of the class "kidney" and the class "amyloidosis" (Figure 17). This could be represented as follows:

$$(M_1 \text{ or } M_2 \text{ or } M_3 \text{ or } M_4) \text{ and } (M_8 \text{ or } M_9)$$

However, in the search equation the OR relationship is represented by a plus (+) sign, while the AND relationship is represented by an asterisk (*). We could therefore rewrite the above equation as follows:

$$(M_1 + M_2 + M_3 + M_4) \quad * \quad (M_8 + M_9)$$

In actual practice, we can compress this equation even further by assigning identifying numbers to sums of terms. Thus, we could say that M_5 = the sum of M_1 through M_4 (i.e., M_1 or M_2 or M_3 or M_4) and that M_{10} = the sum of M_8 through M_9. By adapting these further abbreviations, the whole search equation can now be reduced to

$$(M_5) \quad * \quad (M_{10})$$

or, because (as we will explain later) the parentheses now become redundant, to

$$M_5 \quad * \quad M_{10}$$

Using a very simple example, we have now gone through the entire search formulation process:

1. Analysis of the request and identification of the facets involved.

2. Selection of MeSH terms appropriate to each facet.

3. Assignment of identifying numbers to the terms selected.

4. Preparing summations of terms and a search equation that specifies which combinations of index terms must be present in order to cause a citation to be retrieved.

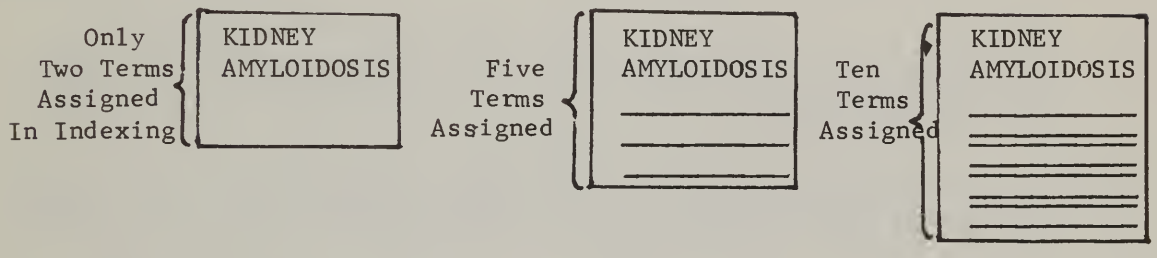
Essentially, this is all that is involved in the process of search formulation. However, we have so far considered only one very easy example. Additional complexities are introduced in the next section.

It is important to recognize that a search formulation is really a condensed statement of all the possible term combinations that could cause a citation to be retrieved. $M_5 * M_{10}$ means that we will accept any citation indexed under a term represented by M_5 (i.e., M_1 through M_4) so long as a term represented by M_{10} (i.e., M_8 through M_9) is also present. In other words, going back to the terms selected above, we want to retrieve only those articles that have been indexed under one of the following term combinations:

KIDNEY and AMYLOID
KIDNEY and AMYLOIDOSIS
KIDNEY GLOMERULUS and AMYLOID
KIDNEY GLOMERULUS and AMYLOIDOSIS
KIDNEY PELVIS and AMYLOID
KIDNEY PELVIS and AMYLOIDOSIS
KIDNEY TUBULES and AMYLOID
KIDNEY TUBULES and AMYLOIDOSIS

By assigning identifying numbers to each term, and by using the standard symbols, we have reduced this statement of acceptable term combinations to the very concise search equation $M_5 * M_{10}$.

It is also important to note that, in the above example, we have not placed any other restrictions on the citations that may be retrieved. That is, we will accept citations to any articles indexed under any of the term combinations listed above no matter what other terms have also been used in indexing. Thus, we are equally happy to retrieve any of the following articles:



More Complex Requests

Many of the requests made to MEDLARS are more complex than the simple two-faceted request used as an illustration above. For example, the requester might have asked for "renal amyloidosis as a complication of tuberculosis" or for the effect of prednisone on this condition. The former request is three-faceted, while the latter involves four facets: kidney, amyloidosis, tuberculosis, and drug therapy (specifically, prednisone therapy). These requests are represented diagrammatically in Figure 19 and Figure 20.

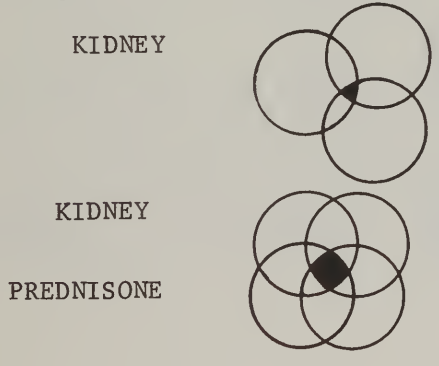


FIGURE 19

FIGURE 20

In the former case we are looking for the intersection of three classes. That is, we are seeking articles indexed under a kidney term and an amyloidosis term and a tuberculosis term. In the latter, we are demanding a fourth intersection: in addition to the above, a term indicating prednisone therapy must also be present.

As the requests get more precise, and we demand that more terms must co-occur in order to cause retrieval, the volume of literature retrieved will become less. Thus, we expect more citations to be retrieved for a search on "renal amyloidosis" than we do for a search on "renal amyloidosis as a complication of tuberculosis", and we expect more on the latter topic than we do on "effect of prednisone in cases of renal amyloidosis complicating tuberculosis."

However complex the request, we can still reduce it to the type of search equation illustrated earlier. For example, the search equation

$$M_5 * M_{10} * M_{20} * M_{25}$$

might be used to express the most complex request mentioned, where M_5 represents a list (sum) of the kidney terms, M_{10} the sum of the amyloidosis terms, M_{20} the sum of the tuberculosis terms, and M_{25} the term PREDNISONE.

From our previous discussion of MEDLARS indexing we know that terms may be assigned to an article to describe aspects other than purely subject aspects. These parameters can also be incorporated in search strategies. For example, we can search for review articles on amyloidosis (Figure 21), for articles on amyloidosis written in French (Figure 22), or for articles on amyloidosis from a particular journal (Figure 23).

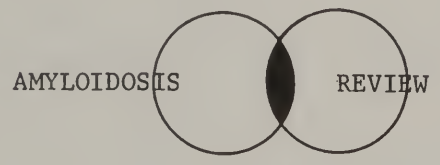


FIGURE 21

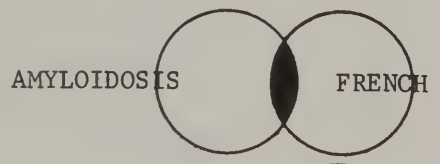


FIGURE 22

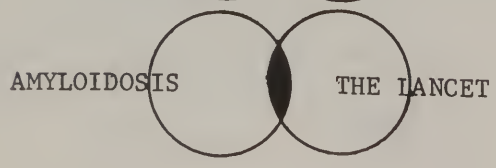


FIGURE 23

Use of Subheadings in Searching

The subheadings, used in combination with main headings to achieve greater specificity, are an important tool to aid the searcher in obtaining improved precision of search. For example, consider the request of a clinician who is looking for any articles that discuss cases of amenorrhea following discontinuance of oral contraceptive therapy. This is a two-faceted request: amenorrhea and oral contraceptives. It may be reduced to appropriate term lists as follows:

M_1 AMENORRHEA

M_5 CONTRACEPTIVES, ORAL

M_6 PROGESTATIONAL HORMONES

M_7 MEDROXYPROGESTERONE

M_8 NORETHINDRONE

M_9 NORETHYNODREL

} Partial List of Appropriate Terms Only

However, if we and AMENORRHEA with the oral contraceptive terms, we may retrieve some unwanted citations on the use of oral contraceptives in the treatment of menstruation disorders. To avoid this, we can make use of the appropriate subheadings "adverse effects" and "chemically induced." We list these subheadings on our search formulation record and give them an appropriate code, as

S_1 adverse effects

S_2 chemically induced

In our summation of the strategy we say:

M_{10} = SUM M5 - M9

$X_1 = M_{10}/S_1$

$X_2 = M_1 /S_2$

The X element represents the combination of a main heading (or a sum of main headings) and a subheading (or a sum of subheadings). In this example, X1 has been defined as the combination of every main heading included in the oral contraceptive facet and the subheading "adverse effects." X2 has been defined as the combination of AMENORRHEA with the subheading "chemically induced."

We can now reduce the entire strategy to the simple search equation:

$$X_1 * X_2$$

which means that we will accept for retrieval any citation indexed under AMENORRHEA with the subheading "chemically induced" as long as an oral contraceptive term, with the subheading "adverse effects," is also present.

The Logical "OR" in Searching

We have already mentioned that the logical or (sum) can be used to indicate terms that are accepted as equivalent (substitutable) for search purposes; e.g., AMYLOIDOSIS or AMYLOID. We can also use logical sums to incorporate alternative search strategies into a complete search formulation. Consider a request for literature on the effect of cortisone on the choroid or the retina. This is represented in Figure 24. Here we are interested in any articles

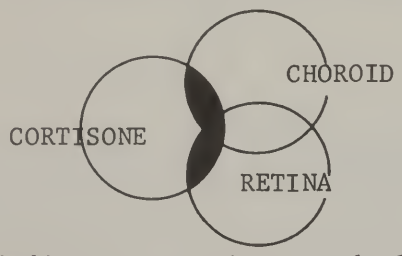


FIGURE 24

indexed under a term indicating cortisone and also a term indicating choroid or retina. We can reduce this to a simple strategy as follows:

M_1 CORTISONE

M_4 CHOROID

M_5 RETINA

$$M_1 * (M_4 + M_5)$$

That is, retrieve any citations indexed under the term CORTISONE and either the term CHOROID or the term RETINA.

A search equation is an algebraic expression with the characteristics of any other algebraic expression. Thus, the terms inside the parentheses are governed by everything outside. That is, M1 * (M4 +M5) is equivalent to M1 * M4 + M1 * M5, which would be another way of writing the same search equation.

$$M_1 * (M_4 + M_5)$$

is not the same expression as

$$M_1 * M_4 + M_5$$

which means anything indexed under M1 and M4 or anything indexed under M5 (alone). See Figure 25. Note that the or (+) has here introduced an alternative search expression.

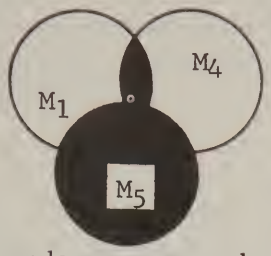


FIGURE 25

The logical or is also made necessary by changes in MeSH terminology over time. For example, consider a request for articles on the treatment of Tinea capitis with antifungal antibiotics. Before 1967, there was no specific MeSH term to cover antifungal antibiotics. They were indexed under ANTIBIOTICS, and under FUNGICIDES. However, the specific term ANTIBIOTICS, ANTIFUNGAL was introduced in MeSH in 1967. To retrieve the 1966 and subsequent literature, we have to say:

TINEA CAPITIS and ANTIBIOTICS and FUNGICIDES

or

TINEA CAPITIS and ANTIBIOTICS, ANTIFUNGAL

This may be reduced to a single search equation:

$$M_1 * (M_2 * M_3 + M_4)$$

where M1 represents TINEA CAPITIS, M2 ANTIBIOTICS, M3 FUNGICIDES, and M4 ANTIBIOTICS, ANTIFUNGAL.

The Logical "Not" in Searching

In addition to using the logical and and the logical or, we can also negate terms by use of the logical not. Consider a request for literature on the effect of cortisone on retinitis but not where the retina is detached (Figure 26).

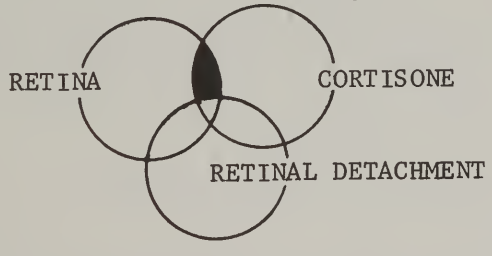


FIGURE 26

Here we are interested in any article indexed under RETINA and under CORTISONE but not if also indexed under RETINAL DETACHMENT. That is, we specifically wish to exclude articles with the term RETINAL DETACHMENT. The negation (not) is expressed by the use of a minus sign (-). In this case we are saying and not (* -) and the search equation can be derived as follows:

M_1 RETINA

M_2 CORTISONE

M_3 RETINAL DETACHMENT

$M_1 * M_2 * - M_3$

In certain other cases we may wish to say or not (+ -) rather than and not (* -). For example, a requester may want to retrieve studies of blood circulation in the choroid in humans only. The check-tag HUMAN is now routinely applied to all articles describing studies in humans. However, this check-tag was not always used in MEDLARS. To retrieve the earlier articles on humans only we have to go the roundabout way by negating animal terms. Thus, a strategy covering the entire data base for the above request will have to say BLOOD CIRCULATION (M1) and CHOROID (M2) and HUMAN (M3) or BLOOD CIRCULATION and CHOROID and not animal terms (M4). This may be reduced to the search equation

$$M_1 * M_2 * (M_3 + - M_4)$$

which reads M_1 and M_2 and (M_3 or not M_4).

Subsearches

The MEDLARS search programs allow up to three subsearches of increasing specificity to be combined within a single search strategy. Consider again the request for literature on renal amyloidosis as a complication of tuberculosis and the effect of prednisone on this condition. Perhaps the requester indicates that he is generally interested in all renal amyloidosis, particularly when this is a complication of tuberculosis. His most particular interest is in the effects of prednisone on this condition. For this request we can create a three-tiered strategy of increasing specificity:

4 all articles on renal amyloidosis
5 renal amyloidosis as a complication of tuberculosis
6 the effects of prednisone on this condition

In MEDLARS the numbers 4-5-6 are used to indicate subsearches of increasing specificity within a complete search formulation. Reduced to a search equation, this will appear as follows:

M_5 terms indicating kidney

M_{10} terms indicating amyloidosis

M_{15} terms indicating tuberculosis

M_{30} the term PREDNISONE

4 M_5 * M_{10}

5 M_{15}

6 M_{30}

What we are saying here is that the broad strategy will retrieve anything on renal amyloidosis. From this subset of retrieved citations, those indexed under a term indicating tuberculosis will be separated out, and from this second subset will be separated out any indexed under the term PREDNISONE. Suppose that 100 citations satisfy the broad search requirement (i.e., they are indexed under a kidney term and also a term for amyloidosis). Of these, 20 also have a tuberculosis term present, and of these, two have been indexed under the term PREDNISONE. A total of 100 citations will be retrieved by this strategy but, when these citations are printed out by the computer, those most specifically related to the requester's need (Section 6 of the bibliography) will appear first, followed by the next most closely related (Section 5), and finally by the residue of citations that satisfy the most general search requirement only, as follows:

Section 6	2 citations
Section 5	18 citations
Section 4	80 citations

for a total of 100 citations satisfying the search logic.

Developing the Lists of Search Terms

In discussing indexing, we pointed out that the most specific available term is always used to describe a concept. Thus, an article on sunburn is indexed under SUNBURN and one on eye burns under EYE BURNS rather than under the more generic term BURNS.

In searching the MEDLARS file, then, for articles on burns (nonspecific) in children, the search analyst must search on each specific "burn" term in the vocabulary, each one anded with terms indicating children. Of course, the term BURNS itself would be searched to retrieve those general references in which no specific type of burn was mentioned and those in which a specific type of burn was mentioned but for which no precise MeSH term exists. These articles (e.g., on friction burns) would be indexed under the general heading BURNS.

In this case the searcher must find all of the MeSH terms, general and specific, under which topics of interest may have been indexed. To do this, several searching aids are used. First, of course, is the alphabetical sequence of terms in MeSH itself. This is the primary source used for determining whether or not a desired heading is in the vocabulary. The cross-references in MeSH lead the searcher to many of those headings which might be considered for searching. In this case (Figure 27), we find no cross-references under BURNS, but we do find four terms we will want to consider:

BURNS
BURNS, CHEMICAL
BURNS, ELECTRIC
BURNS, INHALATION

The searcher may also go to the categorized lists of terms, mentioned in the discussion of indexing, which appear in the blue pages of Medical Subject Headings.

A very important tool used by the searcher is a hierarchical classification of MeSH terms known as the Tree Structures. In this, each of the categories in MeSH has been classified in a hierarchical manner. In Figure 28 we see the MeSH tree covering burns.

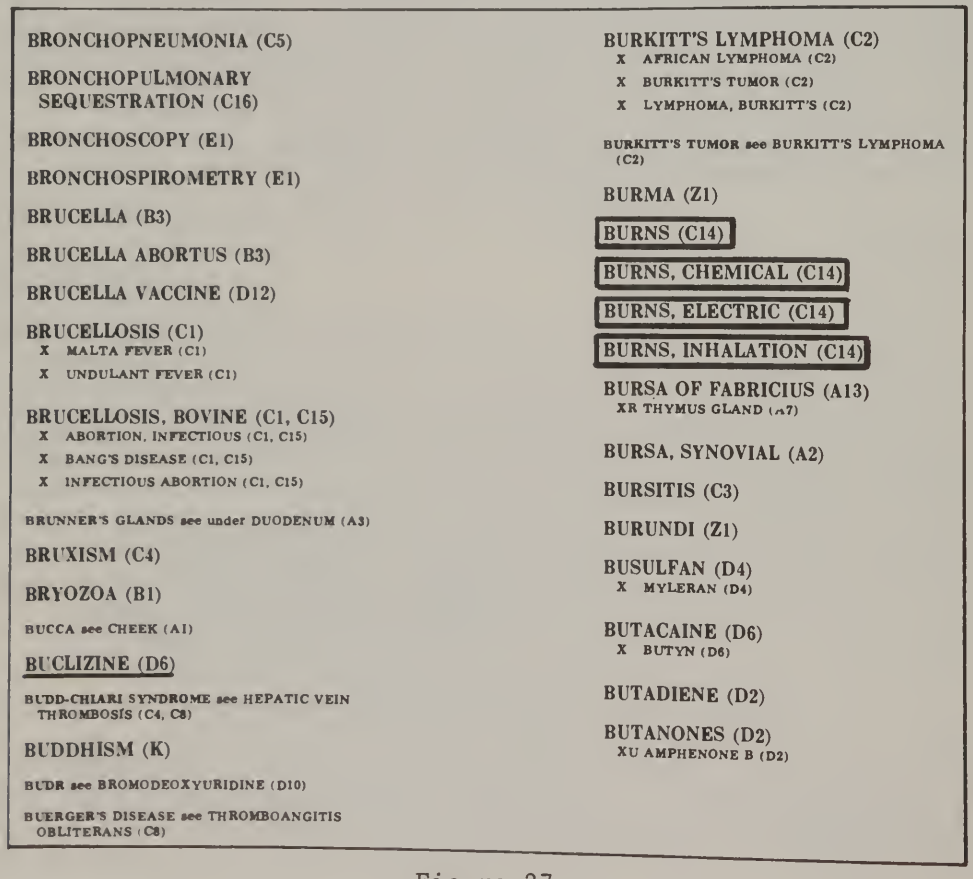


Figure 27

C14 - INJURY, POISONING AND IMMUNOLOGIC DISEASE

INJURY, IMMUNE DISEASE, POISONING (NON MESH) (CONTINUED)		
WOUNDS AND INJURIES (CONTINUED)		
ARM INJURIES (CONTINUED)		
FOREARM INJURIES	C14.88.8.1	
WRIST INJURIES	C14.88.8.1	
ASPHYXIA	C14.88.10.	
ATHLETIC INJURIES	C14.88.11.	
BIRTH INJURY	C14.88.12.	C16.70.8.
BITES AND STINGS	C14.88.13.	C14.66.18.
BLAST INJURY	C14.88.14.	
BRAIN INJURY, ACUTE	C14.88.16.	C14.88.36.1
BRAIN CONCUSSION	C14.88.16.1	
EPILEPSY, TRAUMATIC	C14.88.16.1	C10.18.39.1
PSYCHOSES, TRAUMATIC	C14.88.16.1	F.34.11.1
BURNS	C14.88.18.	
BURNS, CHEMICAL	C14.88.18.1	
BURNS, ELECTRIC	C14.88.18.1	C14.88.24.1
BURNS, INHALATION	C14.88.18.1	
EYE BURNS	C14.88.18.1	C14.88.27.1
SUNBURN	C14.88.18.1	
CONTUSIONS	C14.88.20.	
DISLOCATIONS	C14.88.22.	
HIP DISLOCATION	C14.88.22.1	
SHOULDER DISLOCATION	C14.88.22.1	
ELECTRIC INJURY	C14.88.24.	
BURNS, ELECTRIC	C14.88.24.1	C14.88.18.1
ESOPHAGEAL PERFORATION	C14.88.26.	C4.29.36.
EYE INJURIES	C14.88.27.	

Figure 28

From this listing, the search analyst discovers two additional terms, SUNBURN and EYE BURNS, not found by use of the alphabetical MeSH. As shown in the tree, BURNS is more specific than WOUNDS AND INJURIES and is therefore indented under the latter term. Indented under BURNS are the five specific burn terms. The classification number C14.88.18 has been assigned to the term BURNS and also to all specific burn terms indented under it. C14 is the subcategory Injury, Poisoning and Immunologic Disease. C14.88 refers more specifically to Wounds and Injuries.

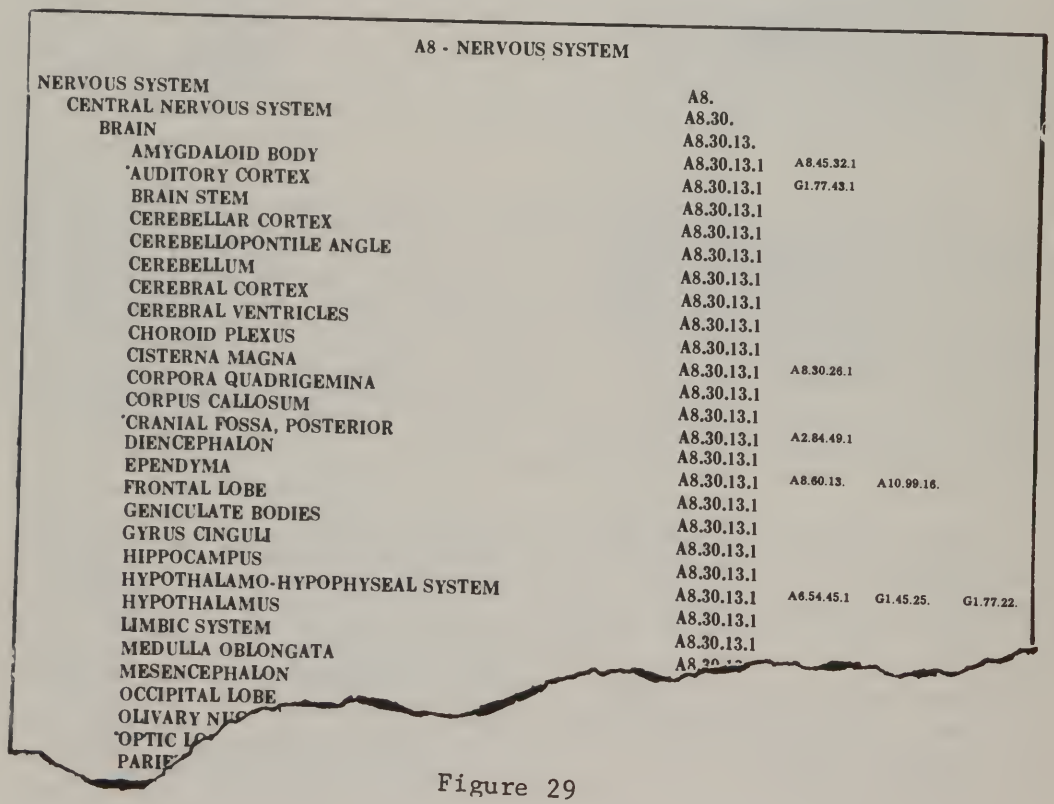
The great advantage of the tree structure is that it minimizes the time needed by the search analyst to conduct comprehensive generic searches. In this instance, if the searcher wants to incorporate all "burn" terms into his formulation, he does not need to make a complete list. He merely records the tree number C14.88.18 and indicates that a generic search (known in MEDLARS as an explosion) is to be conducted on this class. This explosion will retrieve any citation indexed under BURNS and any citations indexed under the specific burn terms subordinated to BURNS in the hierarchy.

The tree structures are even more useful as aids to searching on concepts for which a large number of specific terms exist in the vocabulary. Consider a search relating to the brain for example. All of the specific anatomical terms relating to the brain are shown subordinated to the term BRAIN in A8.30.13 (see Figure 29). The searcher may "explode" on A8.30.13 thereby retrieving citations indexed under any of the specific brain terms, or he may select those brain terms that are most appropriate to the particular search being conducted. It is important that the user indicate, in his request statement, any aspect in which he is not interested. In this instance, if he is not interested in, say, the frontal lobe, he should make this clear in his request.

There are several other headings in MeSH which relate to the brain, and the searcher must at least consider these in building up his formulation. In order to find such terms, the searcher considers the following:

1. Terms with "roots" indicating the brain (e.g., cerebro-encephalo-, cerebello-).

2. "Function words" indicating brain involvement (e.g., the terms BLOOD-BRAIN BARRIER, THINKING, INTELLIGENCE).



A8 - NERVOUS SYSTEM

NERVOUS SYSTEM	A8.			
CENTRAL NERVOUS SYSTEM	A8.30.			
BRAIN	A8.30.13.			
AMYGDALOID BODY	A8.30.13.1	A8.45.32.1		
AUDITORY CORTEX	A8.30.13.1	G1.77.43.1		
BRAIN STEM	A8.30.13.1			
CEREBELLAR CORTEX	A8.30.13.1			
CEREBELLOPONTILE ANGLE	A8.30.13.1			
CEREBELLUM	A8.30.13.1			
CEREBRAL CORTEX	A8.30.13.1			
CEREBRAL VENTRICLES	A8.30.13.1			
CHOROID PLEXUS	A8.30.13.1			
CISTERNA MAGNA	A8.30.13.1			
CORPORA QUADRIGEMINA	A8.30.13.1	A8.30.26.1		
CORPUS CALLOSUM	A8.30.13.1			
CRANIAL FOSSA, POSTERIOR	A8.30.13.1			
DIENCEPHALON	A8.30.13.1	A2.84.49.1		
EPENDYMA	A8.30.13.1			
FRONTAL LOBE	A8.30.13.1	A8.60.13.	A10.99.16.	
GENICULATE BODIES	A8.30.13.1			
GYRUS CINGULI	A8.30.13.1			
HIPPOCAMPUS	A8.30.13.1			
HYPOTHALAMO-HYPOPHYSEAL SYSTEM	A8.30.13.1			
HYPOTHALAMUS	A8.30.13.1	A6.54.45.1	G1.45.25.	G1.77.22.
LIMBIC SYSTEM	A8.30.13.1			
MEDULLA OBLONGATA	A8.30.13.1			
MESENCEPHALON	A8.30.13.1			
OCCIPITAL LOBE				
OLIVARY NU				
OPTIC LO				
PARIE				

Figure 29

3. Diagnostic terms relating to the brain, such as ELECTRO-ENCEPHALOGRAPHY and CEREBRAL ANGIOGRAPHY.

4. Terms indicating pathological conditions (i.e., BRAIN DISEASES).

5. Terms that may indicate surgical procedures on the brain (e.g., CRANIOTOMY).

In addition, the searcher must remember to take into account changes in the MeSH vocabulary over the years. For example, if he is searching the 1964-1965 citations, he must use the pre-coordinated term BRAIN PHYSIOLOGY. For later material he must search on the main heading/subheading combination BRAIN/physiology. In January 1966, subheadings were introduced in MEDLARS. As a result, a large number of precoordinated terms such as BRAIN PHYSIOLOGY which had existed in the vocabulary were de-coordinated to allow for the use of the subheadings. The searcher has tools available to show the evolutionary changes in MeSH terms and also definitions of the scope of these terms.

A further important tool (see Figure 30) is a computer printout of all the main headings and the number of times each has been used in indexing. This number (the tally) is very important to the searcher, for it allows him to make a rough estimate of the number of citations likely to be retrieved by a particular strategy.

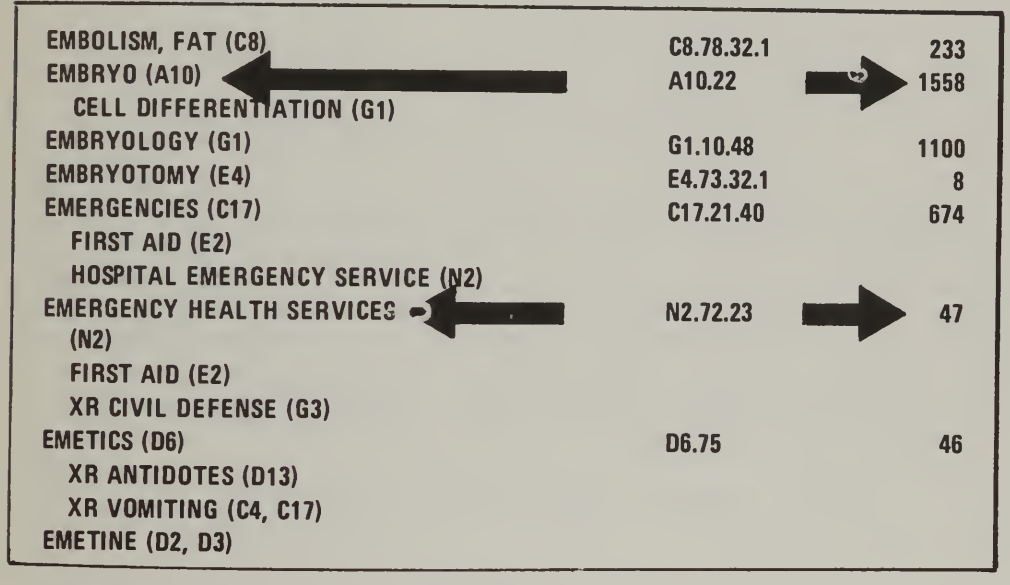


Figure 30

An additional printout shows the number of times a given subheading has been used with a main heading.

The Demand Search Formulation Record (DSFR)

All possible relations between classes of documents (and, thus, the subject headings representing these classes) may be expressed in terms of logical sums (ors), logical products (ands), and logical differences (nots or negations). When reduced to a search equation, these relationships are expressed by +, *, and - . For purposes of illustration, we have drawn our examples from fairly simple requests involving relatively straightforward strategies. However, complex requests, involving many more terms, may be reduced to search equations in the same way.

The search analyst prepares his strategy on a special form known as the Demand Search Formulation Record (DSFR). An example is shown in Figure 31. This particular request is for articles on tissue culture studies of human breast cancer. It has three facets:

1. Breast Cancer
2. Human
3. Tissue Culture

Note how the searcher has divided up his list of terms into separate lists for each facet. The breast cancer terms are two: BREAST NEOPLASMS and CARCINOMA, DUCTAL. To arrive at the requirement for "human," he searches on the term HUMAN and also negates terms indicating animal studies, including the subheading VETERINARY. There are three tissue culture terms to be searched. Finally, he indicates that the search is to be conducted on English-language material only.

Having decided on his search terms, the searcher gives them identifying numbers with the prefix M for main subject headings, S for subheadings, and L for language. He wants to negate all vertebrate terms and all animal disease terms so he lists the category numbers (B2 and C15) and indicates by use of the e in column 17 that these terms are to be exploded. In the central portion of the form he records his summations: M3 for the two breast cancer terms, M16 for the four animal terms, and M23 for the three tissue culture terms. Finally, he reduces the entire strategy to a search equation ("request statement"):

$$M_3 \ * \ (M_{10} + - M_{16} \ * - S_1) * M_{23} * L_1$$

REQUEST NO. 194249

DEMAND SEARCH FORMULATION RECORD

DATE 2 Aug 1969

TITLE

Tissue culture studies of human breast cancer.

11-14 ELEM. SYMBOL	17 EXPL.	18 LEVEL	19-31 CATEGORY NUMBER	ELEMENTS	TALLY
M1				BREAST NEOPLASMS	
M2				CARCINOMA, DUCTAL	
M10				HUMAN	
M11	E		R2	VERTEBRATES	
M12				ANIMAL EXPERIMENTS	
M13				VETERINARY MEDICINE	
M14	E		C15	ANIMAL DISEASES	
M20				TISSUE CULTURE	
M21				CULTURE MEDIA	
M22				CHICK EMBRYO	
L1				ENG	
S1				Veterinary	

11-14 ELEM. SYMBOL	17 EXPL.	18 LEVEL	19-31 CATEGORY NUMBER	ELEMENTS	TALLY

ELEMENTS A, J, I, N, Y, X, AND SUMMATIONS

SECT. 7 3-	ELEM. SYMBOL 11-14	33-36	37-40	41-44	45-48	49-56
	M3	SUM	M1	M2		
	M16	SUM	M11	M14		
	M23	SUM	M20	M22		

SECT. 7 3-	ELEM. SYMBOL 11-14	33-36	37-40	41-44	45-48	49-56

REQUEST STATEMENTS

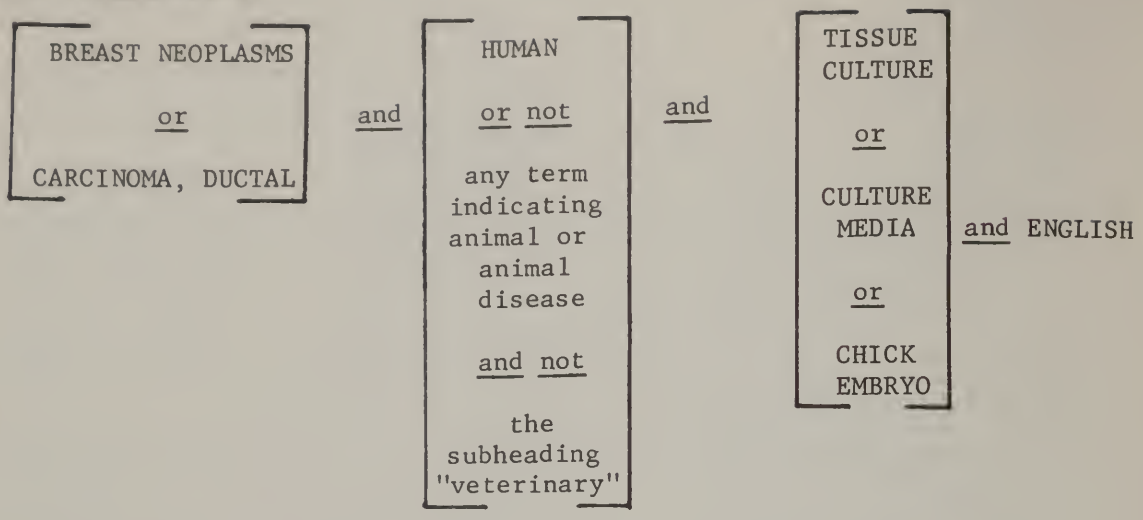
SECT. 7	ELEM. SYMBOL 9-10	11-80 COLUMNS	FOUND
4	1	M3 * (M10 + -M16 * -S1) * M23 * L1.	11

BATCH NO.	DS MODULE	COMMENTS	RG MODULE	COMMENTS

PHS-4667-2 (4-67)

Figure 31

which translates as



No subsearches of increasing specificity were used in this particular strategy because the total volume of retrieval was expected to be low. In actual fact, only 11 citations were found to meet the search requirements.

The Machine Search and Its Output

Once the search strategy has been reduced to an appropriate search equation, the entire formulation -- terms and search equation -- are put into machine-readable form by the use of punched cards. The search is now ready for processing. Several searches are batched together and processed simultaneously, as illustrated earlier in Figure 16. The search formulation is matched sequentially against the complete data base of indexed citations. A citation is retrieved from this data base when its index terms match one of the combinations of index terms demanded by the search strategy. Qualifying citations are copied from the main citation file onto a retrieved citation tape. Before the retrieved citations are printed, however, printing instructions are supplied by the search analyst who formulated the search. The following options are available:

1. The citations may be printed on 3" x 5" cards or on continuous computer paper (8½" x 11").

2. The citations may be arranged in a number of different ways, including:

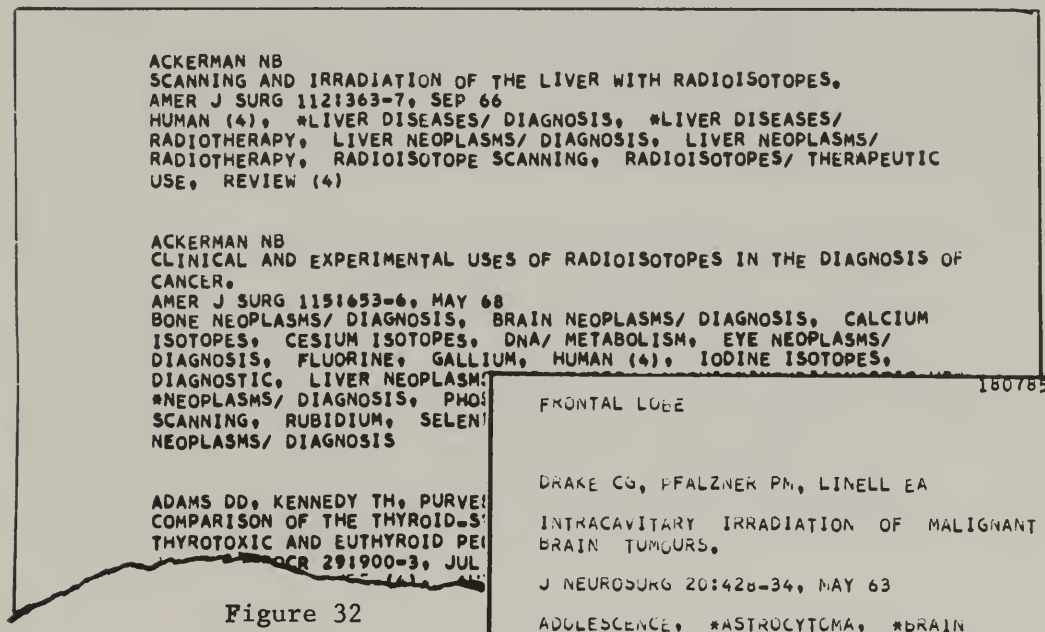
   a. alphabetically by first author,
   b. by journal title abbreviation, or
   c. by language.

Illustrations of partial search printouts in paper and card formats are included as Figs. 32 & 33. Notice that the citations contain -- in addition to the traditional bibliographic reference given in Index Medicus -- a listing of all the headings used in indexing the article. These terms may aid the user in deciding which articles he may want to read.

The searcher's final responsibility is to carefully review the printout for probable success or failure and then to take appropriate action. If the retrieved citations appear to meet the requester's needs, the printout is mailed to him with an explanatory letter. If, in the searcher's estimation, the search results are poor, he may try another approach and reformulate the search, or he may contact the requester and discuss the problem with him. Adequate interaction with the user prior to initial formulation, along with careful thought during the formulation process, will usually avoid the need for reformulation.

RECURRING DEMAND SEARCHES

Some Demand Searches (conducted mainly for Government organizations) are activated periodically (monthly, bimonthly) without the requester having to resubmit his request. These searches are used for a variety of purposes, such as training or keeping an up-to-date file of literature on a specific subject.



ACKERMAN NB
SCANNING AND IRRADIATION OF THE LIVER WITH RADIOISOTOPES.
AMER J SURG 112:363-7, SEP 66
HUMAN (4), *LIVER DISEASES/ DIAGNOSIS, *LIVER DISEASES/ RADIOTHERAPY, LIVER NEOPLASMS/ DIAGNOSIS, LIVER NEOPLASMS/ RADIOTHERAPY, RADIOISOTOPE SCANNING, RADIOISOTOPES/ THERAPEUTIC USE, REVIEW (4)

ACKERMAN NB
CLINICAL AND EXPERIMENTAL USES OF RADIOISOTOPES IN THE DIAGNOSIS OF CANCER.
AMER J SURG 115:653-6, MAY 68
BONE NEOPLASMS/ DIAGNOSIS, BRAIN NEOPLASMS/ DIAGNOSIS, CALCIUM ISOTOPES, CESIUM ISOTOPES, DNA/ METABOLISM, EYE NEOPLASMS/ DIAGNOSIS, FLUORINE, GALLIUM, HUMAN (4), IODINE ISOTOPES, DIAGNOSTIC, LIVER NEOPLASM
*NEOPLASMS/ DIAGNOSIS, PHO
SCANNING, RUBIDIUM, SELEN
NEOPLASMS/ DIAGNOSIS

ADAMS DD, KENNEDY TH, PURVE
COMPARISON OF THE THYROID-S
THYROTOXIC AND EUTHYROID PE
CR 29:900-3, JUL

Figure 32

180785

FRONTAL LOBE

DRAKE CG, PFALZNER PM, LINELL EA

INTRACAVITARY IRRADIATION OF MALIGNANT BRAIN TUMOURS.

J NEUROSURG 20:428-34, MAY 63

ADOLESCENCE, *ASTROCYTOMA, *BRAIN NEOPLASMS, *CESIUM ISOTOPES, *DURA MATER,
CONTINUED

NATIONAL LIBRARY OF MEDICINE (MEDLARS)

Figure 33

LITERATURE SEARCHES

A demand search is usually conducted for an individual and is therefore tailored to the unique information requirements of this person. Sometimes, however, a demand search is conducted on a topic of potentially wide interest (e.g., cardiac resuscitation, heart transplantation). Such a search may be selected for further processing in order that it may be widely distributed. The search then becomes known as a Literature Search. It is subjected to editorial procedures and photocomposed.

As new titles become available, they are announced through notices in the following publications: NLM News, Index Medicus, Monthly Bibliography of Medical Reviews, Journal of the American Medical Association, Journal of the American Dental Association, Drug Research Reports, and Public Health Reports. An up-to-date list of titles, as well as copies of individual bibliographies may be requested without charge from the Literature Search Program, Reference Services, National Library of Medicine.

RECURRING BIBLIOGRAPHIES

A further product from the MEDLARS data base is the series of recurring bibliographies. A recurring bibliography is a periodically published bibliography in a restricted subject area of biomedicine. A complete list of the bibliographies currently produced is included in Appendix C.

A recurring bibliography is produced in much the same way as a demand search. A search strategy is prepared to retrieve all citations relevant to the scope of a particular publication. For example, to produce the Index to Dental Literature a comprehensive strategy is designed to retrieve all citations of dental interest, whether from dental or general medical journals. However, the strategy developed to produce a recurring bibliography is extremely complex, involving the use of many different index terms in many different combinations. Most recurring bibliographies are developed as a joint venture between the National Library of Medicine and a professional medical organization. For example, the Index of Rheumatology is produced for the American Rheumatism Association Section of the Arthritis Foundation. The professional medical organizations involved designate subject experts to work with trained search analysts on the staff of the Library, in the development of an appropriate searching strategy. Usually, a strategy for a recurring bibliography will go through a number of iterations before it is finally accepted as a suitable formulation to produce the publication concerned. It will be subject to further continuous modification to ensure that it remains optimally responsive to the needs of the specialized audience it is to serve.

The search strategy for a recurring bibliography is matched (monthly, bi-monthly, or quarterly, as appropriate) against all the citations input to MEDLARS since the last issue of that bibliography was produced. The magnetic tape of retrieved citations is sorted, formatted, and photocomposed by procedures similar to those used in the production of Index Medicus. The positive camera-ready copy thus created is then delivered to the professional organization sponsoring the bibliography. That organization is responsible for publication and distribution. Figure 34 is a specimen page from one recurring bibliography, the Index of Rheumatology.

INDEX OF RHEUMATOLOGY

a monthly published by
American Rheumatism Association Section
of The Arthritis Foundation
1212 Avenue of the Americas, New York, N.Y. 10036

in cooperation with The National Library of Medicine
Bethesda, Maryland 20014

Vol. 5, No. 3 March 1969

ACETABULUM

Complete replacement arthroplasty of the hip by the ring prosthesis Ring PA.
J Bone Joint Surg [Brit] 50:720-31, Nov 68
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Anat Ans 123:313-36, 1968 (Ger)

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ALKAPTONURIA

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ALLERGY

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AMYLOIDOSIS

[Usefulness of the Congo red test in clinical practice. A new method] Papa C, et al.
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Recent advances in above knee prosthetics. Wilson AB Jr. Artif Limbs 12:1-27, Autumn 68
[Ligament laxity of ankle] Ouellet R, et al.
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[On fractures in ankylosis] Poliono F, et al.
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Reumatismo 19:61-80, Mar-Apr 67 (Ita)
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[Juvenile ankylosing spondylitis] Schilling F, et al.
Deutsch Med Wschr 94:473-8 passim, 7 Mar 69 (Ger)
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Z Klin Chem 6:112-22, May 68 (Ger)
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Probl Tuberk 46:74-80, 1968 (Rus)
[Effect of an ankylosed coxofemoral joint on the contralateral joint] Nazarova RD.
Probl Tuberk 46:33-8, 1968 (Rus)

ARTHRITIS, INFECTIOUS

Acute suppurative arthritis in children. Gustilo RB, et al. Minn Med 52:219-23, Feb 69
Glucose-galactose malabsorption complicated by monilial arthritis. Pruitt AW, et al.
Pediatrics 43:106-10, Jan 69
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[Preliminary observations on the use of cephaloridine in certain skeletal affections] Lai G.
Minerva Ortop 18:190-6, Mar 67 (Ita)
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Pediatriia 12:83-5, Nov 67 (Rus)

ARTHRITIS, JUVENILE RHEUMATOID

Acute suppurative arthritis in children. Gustilo RB, et al. Minn Med 52:219-23, Feb 69
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[Antinuclear antibodies, antipernuclear factor and

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Figure 34

SUITABILITY OF REQUESTS FOR PROCESSING AS MEDLARS DEMAND SEARCHES

There are, of course, some restrictions on the use of the demand search service, as well as on various types of information which MEDLARS is not designed to provide. It is important that you recognize these restrictions; we therefore ask that you not request:

1. Searches of the total MEDLARS file. Although the data base dates back to mid-1963, experience has shown that most MEDLARS users are satisfied with a search of the more recent segment of the file. The Library, therefore, began limiting routine searches of the MEDLARS file to a period of 2½ - 3½ years. Requests for searches of the earlier files will be considered after you have reviewed and evaluated a search of the more recent ones, and sent us a completed appraisal form (enclosed with your bibliography) indicating why it is necessary to have the earlier material. For references to articles published before mid-1963, consult earlier volumes of Cumulated Index Medicus and Current List of Medical Literature.

2. Author searches. The MEDLARS system is not designed to search on authors' names. Author indexes are available in Index Medicus and Cumulated Index Medicus. Authors' addresses are not provided, but can frequently be located in directories.

3. Verification of specific citations. This information is readily available in Index Medicus and elsewhere.

4. Citations on a single subject, or concepts which may be easily coordinated, e.g., bladder neoplasms, cardiovascular complications in pregnancy. These citations may be found readily in Index Medicus under the appropriate headings (BLADDER NEOPLASMS; PREGNANCY COMPLICATIONS, CARDIOVASCULAR).

5. Data or factual information. Standard handbooks, encyclopedias, and monographs should be consulted for specific data or facts.

6. Subject matter not in scope of Index Medicus. Requests on subjects such as animal husbandry or general computer programming should be directed to specialized indexes (Bibliography of Agriculture, Computer Abstracts). For references to proceedings of congresses, symposia, and similar materials, as well as monographs and serials, consult the National Library of Medicine Current Catalog, published monthly with quarterly and annual cumulations.

7. Translations of articles. Local librarians should be consulted for sources of translations or names of translators.

To clarify the types of request that are suitable for processing as MEDLARS demand searches, and the types that are not, and also to illustrate some other reference tools that should be considered in conducting biomedically related searches, it is worthwhile to examine some typical subject requests. Twelve such requests are analyzed below.

1. Pathogenesis, Diagnosis, and Treatment of Hydrocephalus.

This request is not particularly appropriate for a machine search in MEDLARS. It asks for literature on hydrocephalus from virtually every viewpoint. To be complete, therefore, the search would have to be conducted on the single term HYDROCEPHALUS.

Because no coordination of terms is necessary, the search can be done more economically by the requester himself, looking under the term HYDROCEPHALUS and its subheadings in Index Medicus and the Cumulated Index Medicus. However, perhaps the requester is interested in every possible reference to hydrocephalus, even if the reference is very slight. In this case a MEDLARS search may be justified. The printed indexes allow retrieval of only those articles in which hydrocephalus is treated centrally and for which the indexer has indicated that the term HYDROCEPHALUS should be a print (Index Medicus) term.

A MEDLARS search will retrieve these articles plus others that discuss hydrocephalus in a more peripheral way, for which the indexer has assigned the term HYDROCEPHALUS as a non-print term. For the requester who needs these citations of minor relevance to hydrocephalus, it is possible to supplement the manual search in Index Medicus by a machine search conducted on HYDROCEPHALUS only as a non-print term.

2. The Clinical Significance of the Third and Fourth Heart Sounds.

Theoretically this question should be within the capabilities of MEDLARS. However, it cannot be handled well because the specific terms for the third and fourth heart sounds are not available in the MeSH vocabulary at the present time. The most specific term available is HEART AUSCULTATION. Obviously, the great majority of the articles indexed with this term would not be relevant to the specific topics sought by the requester. In this case, then, a better source than MEDLARS or Index Medicus would be a more specialized bibliography related to the subject of cardiology and/or heart disease. For example, we can consult the subject index to Excerpta Medica, Section 18, Cardiovascular Diseases, and find specific subject headings for the individual heart sounds. These subject headings would then lead you to abstracts that deal exactly with the subject requested.

3. The Relationship between Blood and Cerebrospinal Fluid Oxygen Concentrations or Partial Pressures

This is a request that is very appropriate for MEDLARS searching. It has three facets: the oxygen facet, the CSF facet, and the blood facet. A request involving a complex relationship such as this is very difficult to handle by means of a search in a conventional printed bibliography. In MEDLARS, however, we are able to look for the co-occurrence of three concepts rather easily. By searching on a coordination of blood terms, oxygen terms, and CSF terms, we are able to retrieve relevant citations like the one below:

Dunkin RS, Bondurant S

The determinants of cerebrospinal fluid PO2. The effects of oxygen and carbon dioxide breathing in patients with chronic lung disease.

Ann Intern Med 64: 71-80, Jan 66

*Anoxia, Blood Gas Analysis, *Carbon Dioxide/pharmacology, *Cerebrospinal Fluid, *Cerebrovascular Circulation, Human (4), Hypercapnia (3), *Lung Diseases/complications, *Oxygen, *Oxygen Inhalation Therapy, Respiratory Function Tests

4. Asherman's Syndrome of Intrauterine Synechiae

It is possible to conduct a successful search in MEDLARS on this topic even though the MeSH vocabulary does not specifically include the subject headings ASHERMAN'S SYNDROME or INTRAUTERINE SYNECHIAE. We can approach it in other ways: by the use of the term ADHESIONS coordinated with the term UTERINE DISEASES or with subject headings for the specific conditions that make up the syndrome -- menstrual disorders, abortion, secondary sterility.

Another good source of articles on this topic is the Science Citation Index. This published index lists current scientific papers under the papers that they cite. Thus, if we know where Asherman's syndrome was first described, we may be able to locate later papers that cite the original paper and thus have a high probability of being relevant to the subject sought.

This syndrome was first described by J. G. Asherman in Journal of Obstetrics and Gynaecology of the British Commonwealth, 1948. When we check on this citation in Science Citation Index for, say, 1966, we find that Asherman's paper was cited in 1966 by J. R. Postle and by W. J. Sweeney. Full bibliographic references are given for these papers which, because they cite Asherman's original paper, have a high probability of being relevant to the subject of Asherman's syndrome.

5. Nerve Tissue Culture As Affected by Electrical Stimulation, Local Anesthetics, Ganglionic Blocking Agents, and Hypnotics

This is another good MEDLARS search. The subject has wide ramifications and it would be extremely difficult to cover it comprehensively by conventional manual searching. However, it is susceptible to machine search in MEDLARS by coordination of nervous system terms and tissue culture terms and terms for the specific aspects being studied. For each of these facets there are very many different terms in MeSH. These can be searched and coordinated very efficiently by machine. Such a complex search would be very difficult to conduct manually.

6. Potassium Levels in Milk and Milk Products

Processing of this search through MEDLARS would retrieve some citations of interest, but the bibliography produced would not be truly representative of the subject because the journals indexed for MEDLARS cover this subject primarily in relation to human or animal nutrition. A more productive source for this request would probably be Chemical Abstracts, which covers a greater number of journals more directly related to this subject. Because this request has strong agricultural implications, another appropriate source to check would be the Bibliography of Agriculture, published by the National Agricultural Library.

7. Skin Grafts in Monkeys

This is a very good candidate for a MEDLARS search because it is very difficult to search for experimental animals in a conventional printed bibliography. Terms for experimental animals are usually not entry points in published bibliographies, and the user would thus have to rely entirely on the mention of the animal in the title of the article in order to identify pertinent references. This is true also for Index Medicus. Although experimental animals mentioned in an article are always indexed, these terms are rarely made print terms, so that the articles do not appear under the name of the animal in the printed index. However, these entries do appear as searchable terms on the magnetic tape files. Thus, through a MEDLARS search, we can coordinate SKIN/transplantation and MONKEYS and thus achieve a satisfactory retrieval that would not be possible by manual means.

8. Chromosomal Aberrations in Humans, Animals, and Plants

In this case a MEDLARS search could produce results on chromosomal aberrations in humans and animals but would retrieve little, if anything, on the plant aspect. Possibly the best source for this request would be Biological Abstracts, using the terms CHROMOSOME and CHROMOSOMAL as entry points to the permuted subject index, Biological Abstracts Subjects In Context (BASIC).

9. Medicine and Medical Care in Massachusetts

MEDLARS is well equipped to handle this search because indexers are required to use geographic subject headings in indexing articles about a particular place. A machine search can be conducted on these geographic terms, whereas they are difficult to search on in conventional printed indexes, including Index Medicus. Such articles would be retrievable on a manual search only if the geographic name happened to be mentioned in the title of the article.

10. Use of the Bender-Gestalt Test in Screening for Maladjustment

A good response to this request can be obtained through MEDLARS, which uses BENDER-GESTALT TEST as a subject headings and also has many terms for psychological conditions and psychiatric disturbances. Journal coverage in MEDLARS is good in this area, with over 100 journals indexed in psychiatry and another 60 or so in psychology. Another obvious source for this request would be Psychological Abstracts.

11. Pneumoencephalography, Angiography, Electroencephalography, Echoencephalography, or Brain Scanning in Children Up to Four Years of Age

Several factors make this request well-suited for a MEDLARS search. Age groups are routinely identified and indexed whenever an author indicates the ages of his patients in an article. It is difficult or impossible to search on age groups in printed bibliographies. Only in those rare cases when the author has indicated the age of his patients in the title of his report could such articles be retrieved. The large number of other factors in this question, the radiographic and electrodiagnostic techniques, are also well suited to MEDLARS, and the coordination of these terms with the age group term can be done easily and effectively.

12. Spectrochemical Methods for the Determination of Calcium

Any MEDLARS retrieval on this subject would be restricted to calcium in biological systems, whereas that may not be the intent of the request. A better source would be Chemical Abstracts, which is not limited to biological determinations but covers determinations of calcium wherever it occurs.

In the above examples, we have attempted to give some indication of the types of request that are suitable for machine search in MEDLARS and the types that are less suitable. We have illustrated the use of certain other sources that are appropriate to search for various types of biomedically-related requests. Only the major general tools have been mentioned. There are many other specialized bibliographies appropriate to specific subject requests, for example: International Pharmaceutical Abstracts, Arthritis and Rheumatic Diseases Abstracts, Abstracts of Hygiene, and Tropical Diseases Bulletin.

You should also remember that MEDLARS is largely restricted to coverage of the journal literature. There is also much technical report literature dealing with biomedical subjects, and published indexes are available to locate these reports. For example, space medicine is well covered in Aerospace Medicine and Biology, while biological effects of radiation is well covered in Nuclear Science Abstracts.

FACTORS AFFECTING PERFORMANCE IN MEDLARS

A computer-based retrieval system does not "deliver the answers" at the push of a button. The success or failure of MEDLARS, or any other information retrieval system, is dependent less on machine capabilities than on intellectual effort. This intellectual effort is exerted by the indexers, the search analysts, the vocabulary specialists and - very importantly - by the user himself. Generally speaking, the more effort the requester is willing to put into the use of MEDLARS, the better the result is likely to be.

It is important to recognize that, for a particular request, the great majority of articles in the data base will not be relevant. Assume a MEDLARS data base of one million citations. For a particular specific request there may be, say, 20 relevant articles in the entire file. In other words, there are 999,980 non-relevant articles. We must not expect the MEDLARS search to retrieve only 20 citations, all of them relevant. This is fantasy.

A more realistic result would be a search that retrieved 25 citations, 12 relevant and 13 not relevant (Table II). We can express this result quantitatively by means of some simple ratios. The search has retrieved 12 of the 20 relevant articles contained in the data base. We can therefore say that the recall ratio for the search is 12/20 or 60%. In retrieving these 12 relevant citations, we have also retrieved 13 citations that the requester judges to be irrelevant. Therefore, the precision ratio of the search is 12/25 or 48%. This particular search, then, has operated at 60% recall and 48% precision.

Unfortunately, recall and precision tend to vary inversely. That is, if we create a broad strategy that ensures high recall, we will, at the same time, tend to be operating at a low precision. On the other hand, if we create a very tight or stringent strategy in order to achieve a high precision, we will tend to be operating at a low recall.

Consider (Table III) the request for literature on renal amyloidosis as a complication of tuberculosis. As we know, this request has three facets: the kidney facet, the amyloidosis facet, and the tuberculosis facet. We can prepare a very tight strategy for this request by specifying that a citation will only be retrieved if it has been indexed under a kidney term and a term indicating amyloidosis and a term indicating tuberculosis.

We can expect that this tight strategy will retrieve comparatively few citations and that these citations will mostly be relevant. For example, it may be that the search retrieves only 20 citations, of which 18 are relevant and two are not relevant. The precision ratio is therefore 18/20 or 90%.

However, the 18 relevant citations retrieved may represent only a fraction of the total of relevant citations in the system. Perhaps there are 40 relevant citations in the data base. This search has retrieved only 18/40 or 45% (i.e., the recall ratio of the search is 45%).

Alternatively, we could relax the search requirements by formulating a broader strategy. We could specify that two terms only need co-occur to cause retrieval: either a kidney term and an amyloidosis term or an amyloidosis term and a tuberculosis term. Now we are likely to retrieve many more citations and in so doing we will pull out a greater proportion of the relevant literature. By broadening our search strategy we tend to compensate for the fact that all indexing is selective. Perhaps there are articles dealing in some way with "renal amyloidosis as a complication of tuberculosis" in which the kidney aspect has not been brought out in indexing. These would be retrieved on the combination of an amyloidosis term and a tuberculosis term only.

This broader, more relaxed strategy will probably give us a high recall, perhaps retrieving 38 of the total of 40 relevant articles (i.e., a recall ratio of 38/40 or 95%). However, in broadening the strategy we will also be retrieving many irrelevant items (for example, articles discussing the co-occurrence of amyloidosis and tuberculosis but not renal amyloidosis). Perhaps the search now retrieves 180 citations of which only 38 are relevant. Precision has now dropped to 38/180 or 21%.

The above example, which is hypothetical, illustrates an important fact that we should be aware of in using an information retrieval system: the fact that recall and precision do tend to pull against one another. Broad searches achieve high recall but low precision, while highly specific searches achieve high precision but low recall.

TABLE II

20 RELEVANT
999,980 NOT RELEVANT

FANTASY	FACT	
20 Retrieved All Relevant	25 Retrieved 12 Relevant 13 Not Relevant	RECALL 12/20 = 60% PRECISION 12/25 = 48%

TABLE III

RENAL AMYLOIDOSIS AS A COMPLICATION OF TUBERCULOSIS
(40 relevant articles)

KIDNEY and AMYLOIDOSIS and TUBERCULOSIS		KIDNEY and AMYLOIDOSIS AMYLOIDOSIS and TUBERCULOSIS	
20 Retrieved 18 Relevant	RECALL 18/40 = 45% PRECISION 18/20 = 90%	180 Retrieved 38 Relevant	RECALL 38/40 = 95% PRECISION 38/180 = 21%

In fact, we can show the average operating range of a retrieval system as a curve plotting recall against precision (Figure 35). By varying our searching strategies, we can range up and down this performance curve -- to give us high recall (but low precision), high precision (but low recall), or a compromise between these extremes.

This phenomenon is exactly analogous to what happens when we conduct a conventional manual literature search in published bibliographic sources (Figure 36). If we look only under the most pertinent headings in only the most likely sources, we are going to find mostly relevant literature but not all of it (i.e., we achieve high precision but low recall). On the other hand, if we search under many possible related headings in many different sources, we are likely to retrieve much more of the relevant literature but we will have to wade through many irrelevant references at the same time. In this situation, we are getting high recall but low precision. The same principle applies to mechanized retrieval systems.

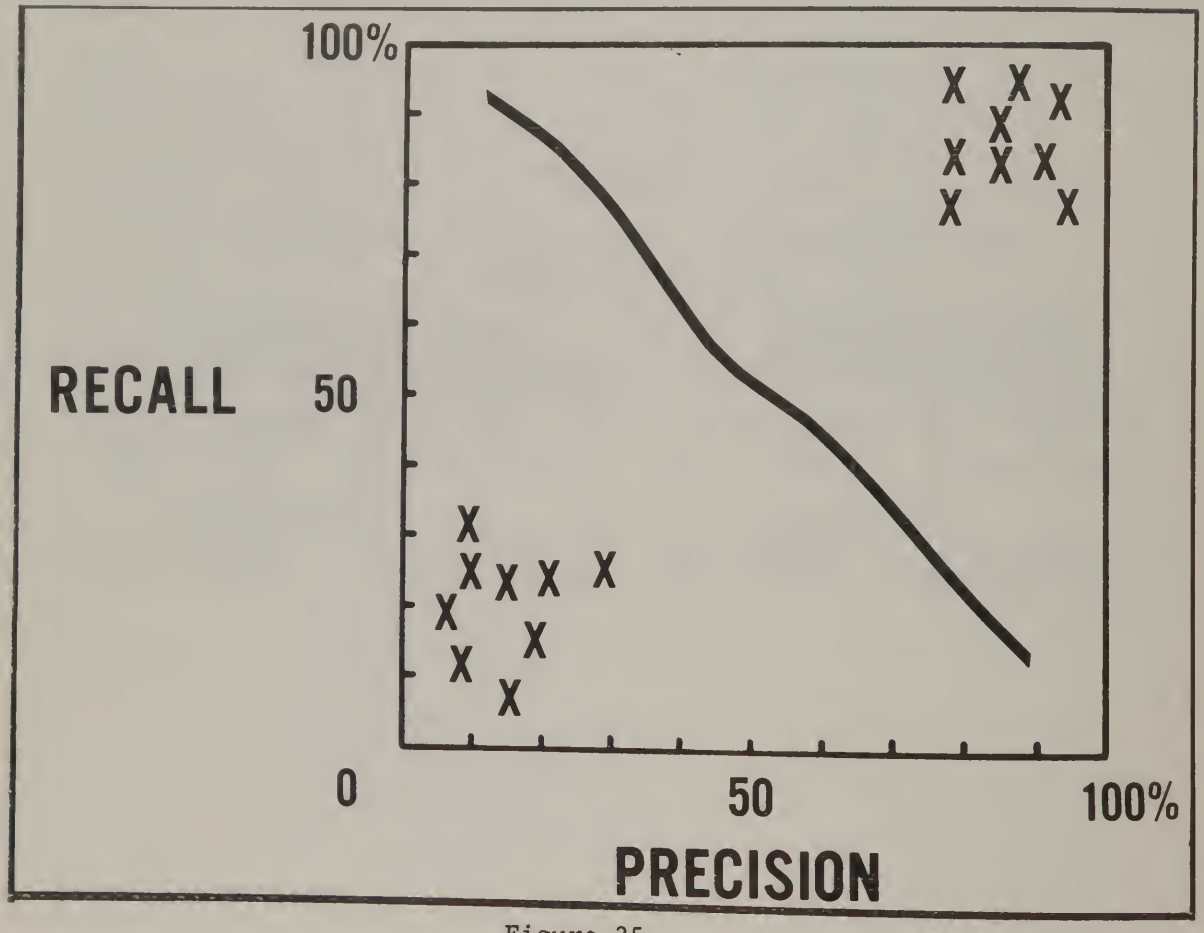


Figure 35

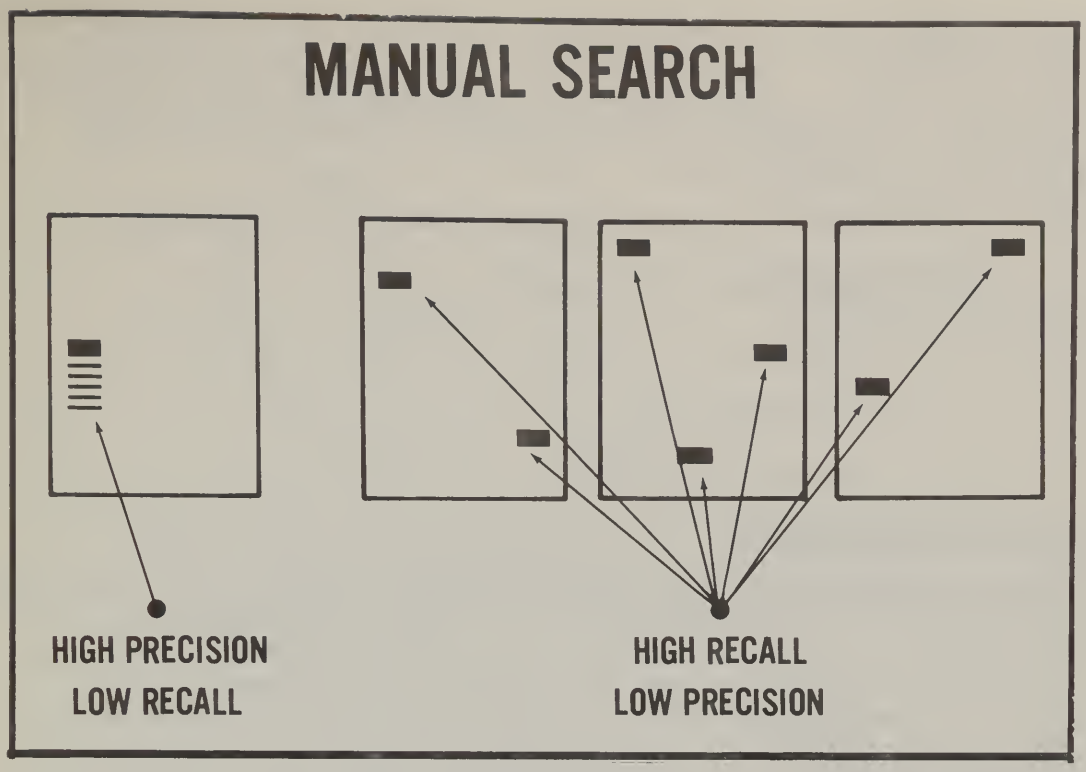


Figure 36

Factors Affecting Performance of a Search

Although we spoke earlier of an operating performance curve for a retrieval system, this curve represents only an average performance range. In some searches (Figure 35), MEDLARS is able to achieve very good results (high recall and high precision) towards the top right-hand corner of the diagram. In other cases, hopefully less frequent, the results turn out rather worse and fall in the lower left-hand corner of the diagram (low recall and low precision).

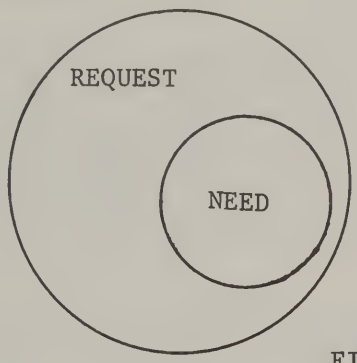
What, then, are the factors that determine whether or not a particular search will achieve satisfactory results? We can say quite definitely that the success or failure of a search is not dependent on the computer and the data processing capabilities of MEDLARS. The computer merely acts as a matching device. It matches the index terms assigned to articles against the combinations of index terms that have been used to describe requests (i.e., the search formulations). When a match occurs, a citation is retrieved.

The principal problems of information retrieval, and the factors that determine the success or failure of a search, are intellectual problems. These problems are largely linguistic problems of semantics and syntax. The specific components of the retrieval system that govern its performance are:

1. the interaction between the requester and the system,
2. the complexity of the request,
3. the indexing,
4. the vocabulary, and
5. the search strategies.

User-System Interaction

A very important factor governing the success or failure of a search is the quality of the request made to the system. A request is a description of an information need. The more accurately this description reflects the true requirements of the requester, the better the search is likely to be. Sometimes a user will make a request that is much more general than the precise topic upon which he needs information, as in the real example included as Figure 37. Under such conditions, he must expect a search containing much irrelevancy.

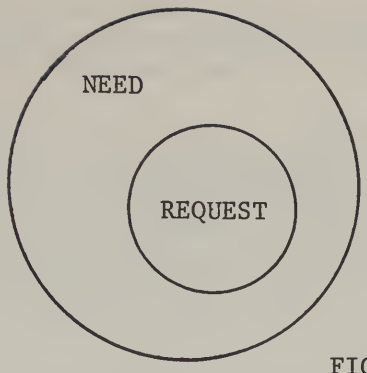


REQUEST
Cancer in the fetus or newborn infant

INFORMATION NEED
Relationship between teratogenesis and oncogenesis at the cellular level

FIGURE 37

On other occasions, the reverse occurs (Figure 38). Here the requester actually asks for something more specific than the true area of his interest: fatty acids rather than lipids in general. In this situation, the requester is going to receive only part of the literature of interest to him.

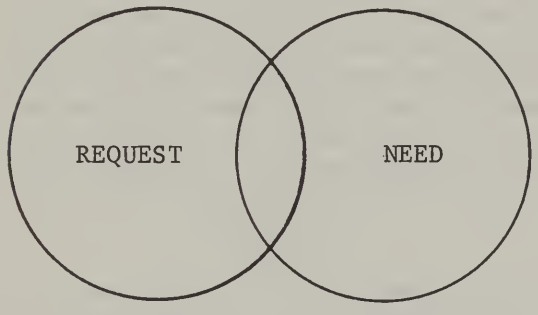


REQUEST
Crossing of fatty acids through the placental barrier

INFORMATION NEED
Crossing of lipids through the placental barrier

FIGURE 38

In yet other situations (Figure 39), the stated request may only partly overlap the information need. In this example, the request is partly more specific than the actual information requirement and partly more general. As a result, both recall and precision failures are likely to occur.



REQUEST
Homonymous hemianopsia in visual aphasia

INFORMATION NEED
Homonymous hemianopsia and other visual field defects in patients having aphasia as a result of a tumor or cerebrovascular accident

FIGURE 39

For a search to be successful, then, it is obvious that the request statement must accurately represent what the requester is really seeking from the search. A poor request almost automatically dooms a search to failure.

Complexity of Requests

A second factor that affects the performance of a search is the sheer complexity of the request. Some requests are easy to handle because they involve few concepts in precise relationships. Consider the following two requests:

1. Crystalline lens in vertebrates, excluding humans.

2. Synthesis of virus specific proteins and nucleic acids formed during the replication of RNA viruses (specifically, vesicular stomatitis virus) in animal and bacterial cells.

The former request is relatively simple and here we can reasonably expect to achieve both high recall and high precision. On the other hand, the second request is much more difficult, involving complex concepts in complex relationships. MEDLARS could achieve a high recall on this search, but probably only at the expense of a low precision.

Indexing

Indexing policies and procedures obviously exert a tremendous effect on the performance of the system. Indexers are human, and sometimes they make mistakes. The most common type of mistake is the omission of an important term. Such errors do occur on occasion. Another factor is that of indexing policy. Indexing is a selective process. Generally, we do not index everything in an article. We index only the more important topics or themes. Consider an article that discusses 10 related topics. If we index all 10 we are being exhaustive in our indexing. When we index everything exhaustively ("in depth"), we have the ability to achieve a high recall: the article can be retrieved in response to a request that relates to any one of the 10 topics, as long as these have been indexed. If, on the other hand, a requester asks for literature on topic 8, and this particular aspect has not been covered in the indexing, the article will not be retrieved.

However, when we do index very exhaustively, we inevitably tend to be indexing some very minor aspects of articles. Consequently, articles are retrieved in response to requests for which they contain very little information and are judged to be irrelevant to the request. Thus, exhaustive indexing (a large number of terms used) will lead to high recall but low precision. Selective indexing (i.e., indexing the most important topics only) will, on the other hand, tend to produce high precision but low recall.

For certain requests, we find that we have not indexed exhaustively enough and therefore miss certain articles that the requester would like to see. For other requests, some of the indexing tends to be too exhaustive, and articles are retrieved which contain only very slight reference to the topic of the request. We attempt to compromise in our indexing by choosing what we feel is an optimum level for the majority of requests made to MEDLARS.

Vocabulary of the System

The vocabulary of MEDLARS (Medical Subject Headings and other components) will obviously exert a great influence on the performance of the system. There are really two major components of the vocabulary:

1. Medical Subject Headings. The terms that an indexer must use to describe the contents of the articles.

2. Entry Vocabulary. This consists of references from medical terms that occur in the literature to the appropriate MeSH term or term combinations.

Frequently, the vocabulary will allow us to express a particular concept quite specifically. When we come to search on this subject, we can retrieve the relevant citations with very little irrelevancy. Both recall and precision may be high under these conditions.

In other instances, we cannot express a topic precisely but must use a more general term to describe it. For example, there is no specific term, or combination of terms, in the vocabulary to precisely express the genetic concept "equational division" (Figure 40). This topic is indexed under the more generic term MEIOSIS. This means that when we do a search on the specific topic, we can retrieve articles on "equational division," but only as part of the broader class MEIOSIS.

FIGURE 40

In other words, we are forced to retrieve all meiosis articles and many of these will be irrelevant to the specific concept "equational division." The precision of a search on this subject is likely, therefore, to be very low. However, we have included the expression "equational division" in our entry vocabulary and are thus able to retrieve articles on this subject. If we did not include it in our entry vocabulary, different indexers might use different subject headings to describe it. Indexing inconsistency will result and the searcher may not search under all possible headings for literature on this precise topic. Recall failures will therefore occur.

Other search failures are caused by ambiguous or spurious relationships between terms. For example, suppose a requester is interested in literature on the co-occurrence of mongolism and leukemia in the same patient. This search is conducted on the combination:

(any mongolism term) and (any leukemia term)

This search retrieves some relevant articles, but, at the same time, brings out some irrelevancy. This is because it retrieves some articles that discuss a number of different patients, some of whom have mongolism and some leukemia, but these conditions do not co-exist in the same patient. This is a false coordination. The two terms that caused the retrieval are essentially unrelated in the retrieved article.

A second type of failure, due to syntactical problems in the vocabulary, we can call an incorrect term relationship. This is the situation in which the two terms that caused retrieval are related in the retrieved article but not in the way that the requester wants them related. For example, a search is conducted on the subject of bovine leukosis. One term combination searched on is CATTLE and LEUKEMIA. Some of the articles retrieved do not deal with cattle leukosis but with the reaction of sera from human leukemia patients with bovine cell cultures.

Searching Strategies

The final factor governing success or failure of a MEDLARS search is the quality of the search strategy. As mentioned previously, a search can be made very general, in order to ensure high recall, or it can be made highly specific to achieve high precision. With a broad search, we are almost bound to have irrelevancy. With a highly specific search, we are almost sure to miss some of the literature. Quite often, the searcher will compromise by designing a strategy that will retrieve most of the relevant literature, but, at the same time, will operate at a tolerable precision.

If we want to achieve high recall, it is important that the search analyst be comprehensive in his strategy. That is, he must cover all reasonable approaches to retrieval. Consider a search for literature on "oral manifestations of neutropenia." Neutropenia is covered by the MeSH term AGRANULOCYTOSIS. The search was conducted on the following strategy:

AGRANULOCYTOSIS and ORAL MANIFESTATIONS
or
any anatomical term indicating the oral cavity (e.g., MOUTH, LIP, GINGIVA)

However, this strategy is not fully comprehensive because the searcher has not used any terms indicating specific oral manifestations (e.g., stomatitis). Therefore, some of the relevant literature was missed by this search.

USING THE SYSTEM MOST EFFECTIVELY

In the above discussion, we have attempted to illustrate the major factors governing the success or failure of a MEDLARS search. It is clear that these are not machine factors. Rather, they are intellectual problems relating to indexing, vocabulary control, searching strategies, and the quality of requests.

What can you, the user, do in order to make the best possible use of MEDLARS? First and foremost, you must be prepared to put effort into making your exact needs known to the system. It is important that you exercise as much care as possible in completing the MEDLARS Search Request Form (see Appendix A).

Section 9 of the form provides for a detailed statement of the subject matter on which you are requesting a search. Be as specific as possible and define any terms that may have special meaning in your request. Use your own terms in describing your need. Do not try at this point to phrase your request in terms selected from Medical Subject Headings.

In Section 10, record the purpose for which the search is being conducted. Sometimes this helps to clarify a request statement that is otherwise obscure. For example, one requester asked for a search to be conducted on "body heat and body temperature as related to perspiration, water vapor, and inert gases." It was only when he indicated the context of his request -- he was working on thermal comfort of astronauts in space cabin atmospheres -- that his request became more meaningful.

Section 11 is extremely important. It provides check-off boxes to help you to limit the scope of your request, where such limitations are appropriate. For example, you may be interested only in humans or only in certain animals. You may be interested in a particular organ under normal conditions or only under pathological conditions. The form helps you to be more precise in making your needs known to the system.

In Section 12, please record citations to any papers that you already know to be relevant to your request. These have a dual purpose. First, they give the searcher further help in understanding the exact area of your interests. Second, they can be used by the searcher, after the search is conducted, to judge how successful the search has been. If you found some of these relevant papers in Index Medicus, it may be useful if you record the subject headings under which these citations were discovered.

Finally, in Section 13 of the form, you are asked to make an estimate of how many articles on the subject of your request you expect to have been published in the last three years. Also, you are asked to indicate whether you want the search to be broad, to ensure high recall, or narrow, to ensure high precision. As emphasized earlier, it is extremely important that your request accurately reflect your exact information requirements. The request form is designed to help you make these requirements known to us as clearly as possible.

There is one more way in which you can help us to improve the performance of MEDLARS. When we send you the search results, we will enclose a search appraisal form. This is a short form (see Figure 41) designed to record your comments on the adequacy of the search. We ask you to be sure to complete and return this form. It is pre-stamped and pre-addressed.

These appraisal forms allow us to identify searches that have produced poor results and help us to determine why. On the basis of this analysis, we are able to make improvements in our vocabulary, our indexing policies, and our searching methods. By these continuous quality control procedures, we can take any corrective action needed to keep MEDLARS responsive to the needs of the biomedical community.

MEDLARS CENTER:
SEARCH ANALYST:
REQUESTER:
SEARCH NO.:
DATE RELEASED:

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF H.E.W.

Quality Control Staff
Bibliographic Services Division
National Library of Medicine
8600 Rockville Pike
Bethesda, Maryland 20014

FOLD ON DASHED LINE

FOLD ON DASHED LINE

MEDLARS SEARCH APPRAISAL

IT IS IMPORTANT THAT WE RECEIVE AN INDICATION OF HOW WELL THIS SEARCH HAS SATISFIED YOUR REQUIREMENTS. This will indicate system effectiveness and allow us to correct any failures. This continuous evaluation will enable us to provide users with the best possible search results. We urge you to please answer the following questions and return the form to us. It is pre-franked and pre-addressed for your convenience.

1. Your search printout contains _____ citations. Please indicate approximately how many of the articles cited are: directly relevant _____, peripherally relevant _____, and, not relevant _____, to your information needs.

2. Consider the articles that you judged not relevant. There are several possible reasons why an article may be "not relevant" *(e.g., it relates to a topic outside the scope of your request or it deals with the required subject but from a viewpoint different from that requested.)* Please give specific details as to why certain articles retrieved by this search are not relevant to your information needs:

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BUREAU BUDGET NO. 68R891
APPROVAL EXPIRES: 6-71

Figure 41

3. Consider the articles that you judged relevant. How many of these were brought to your attention for the first time by this MEDLARS search?

4. Of all the relevant articles that you know to have been published from January 1967 to date, this MEDLARS search retrieved:

☐ APPROXIMATELY 100% ☐ APPROXIMATELY 50%

☐ APPROXIMATELY 75% ☐ APPROXIMATELY 25% OR LESS

Please give citations for any relevant articles *(published from January 1967 to date)* that were not retrieved by this MEDLARS search:

	AUTHOR(S)	TITLE OF ARTICLE	JOURNAL	DATE
(1)				
(2)				
(3)				
(4)				
(5)				

5. Was this search of material value *(e.g., time or effort saved, duplication avoided)* to your investigation? If so, in what way was it of value? If not, why was it of no value?

6. Having seen the results of this search, do you feel that the wording of your request clearly indicated the type of articles that you were looking for? If, in the light of the search results, you can now re-phrase your request more precisely, please do so. Please state items you are explicitly interested in as well as items in which you are not interested.

7. Did you receive the citations in time to be of use? *(Please check the appropriate box)*

☐ YES or ☐ NO

Thank you very much for helping us in the continuous monitoring of MEDLARS performance.

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Figure 42

1969-358-245

SUBMITTING REQUESTS

When the request has been completed, send it to your regional medical library or nearest MEDLARS center. (See Appendix D) MEDLARS search requests sent directly to the National Library of Medicine will be referred to the appropriate MEDLARS center.

There is no charge at present for the Demand Search Service at MEDLARS centers within the United States; however, we require that you complete a form appraising the bibliography you receive.

A list of foreign MEDLARS centers is also found on Appendix D. Users in foreign countries receiving services through the Agency for International Development (AID) may send requests to the Head, MEDLARS Management Section, Bibliographic Services Division, National Library of Medicine, 8600 Rockville Pike, Bethesda, Maryland 20014.

The processing time for a demand search from the time the request is received is approximately two to three weeks.

ACCESS TO ARTICLES CITED IN MEDLARS BIBLIOGRAPHIES

The 2,300 journals indexed for MEDLARS are listed in the List of Journals Indexed published annually by the Library. Access to the original publications cited, to reprints, or to copies of articles may be had from the following sources:

1. Reprints of articles are frequently available directly from the author or publisher.

2. Medical libraries in local university medical centers, medical schools, health centers, hospitals, and state or county medical societies often have the material on hand, or by means of union lists know where it can be obtained through interlibrary loan.

3. Special libraries or libraries of national associations in the various fields of medicine can provide much of the literature that is indexed.

4. If your librarian cannot obtain the material through interlibrary loan elsewhere, the loan request may be directed to Regional Medical Libraries, such as the Francis A. Countway Library of Medicine in Boston, which accept requests from libraries in their Region.

5. If there is no Regional Medical Library in your Region and the other sources have failed to produce the article cited, librarians are authorized to request the material from the National Library of Medicine, according to the NLM Interlibrary Loan Policy.

NATIONAL LIBRARY OF MEDICINE
MEDLARS MANAGEMENT SECTION
8600 Rockville Pike
Bethesda, Maryland 20014

MEDLARS SEARCH REQUEST

DATE: 3/4/69

Is this your first request to MEDLARS? [X] YES [ ] NO

1. INDIVIDUAL WHO WILL ACTUALLY USE THIS BIBLIOGRAPHY

First	Middle	Last Name	TELEPHONE NO.
John	Stuart	Reynolds, Ph.D.	301- 873-9322

2. TITLE: Assistant Professor of Environmental Health

3. ORGANIZATION (Department, Bureau, Branch, Division, etc.): Department of Environmental Health
School of Hygiene

4. ORGANIZATION (University, Corporation, Company, etc.): Johns Hopkins University

5. STREET ADDRESS AND CITY: 611 N. Wolfe Street Baltimore

6. STATE AND ZIP CODE: Maryland 21205

7. REQUEST SUBMITTED BY (If different from above): Mary Hartshorn, Librarian

TELEPHONE NO.: 301- 873-5221

8. SEARCH ANALYST (Leave Blank)

The requester identification (items 1 through 7) should include your full name, degree, telephone number, position, organization, and full address. Please be certain to include your telephone number so the search analyst who handles your request may contact you if necessary.

ALL OF THE QUESTIONS THAT FOLLOW ARE DESIGNED TO PROVIDE INFORMATION NEEDED TO DEVELOP A BIBLIOGRAPHY THAT IS RESPONSIVE TO YOUR NEEDS. YOUR CARE IN PROVIDING FULL INFORMATION WILL AFFECT THE USEFULNESS OF THE CITATIONS THAT YOU WILL RECEIVE.

9. DETAILED STATEMENT OF REQUIREMENTS: Please describe, in your own words, the subject matter for which the search is to be conducted. Be as specific as possible. Define any terms that may have special meaning in your request. Also if there are points NOT to be included, please state these.

I am interested in articles on the effects of atmospheric contamination on health, specifically studies on air contaminants such as hydrocarbons and other carcinogens.

I am not particularly interested in smoking as it affects health, but articles on primary lung cancer in non-smokers are of interest to me.

Under item 9 state your needs without being limited by any preconceived ideas about what MEDLARS can or cannot do for you. Do not attempt to translate your question into words that you feel may be easier for a non-specialist to understand, because you may distort your actual intention. It is the MEDLARS analyst's job to understand your request in your own terms. If necessary, he will call you for clarification.

Please avoid the use of terms that are either more general or more specific than you really intend. Do not say aromatic hydrocarbons if you mean anthracenes; do not say aromatic hydrocarbons if you are interested in all hydrocarbons.

10. SEARCH PURPOSE: Please indicate the purpose for which this search will be used (e.g., preparation of a book, book chapter, journal article, or review article; for immediate clinical application; ongoing research; prospective research; grant application; paper presented at symposium, etc.). Give specific details that will put your request into context.

I am writing a critical review on carcinogens as air pollutants.

For item 10 you should state fully the purpose for which the search is being requested. This information places your request in the context of that purpose, and materially aids the MEDLARS analyst in preparing your search for processing.

11 SEARCH LIMITATIONS: Please check all boxes that are appropriate to the scope of your request. State your needs as specifically as possible, even though we may not be able to meet these precise needs in some cases. Your replies will allow the search analyst to design a strategy that, as far as possible, will avoid types of literature that are of no interest to you.

[X] NO RESTRICTIONS

[X] HUMAN SUBJECTS

[ ] VETERINARY MEDICINE: If only certain animals or animal groups are of interest, please list these:

[X] ANIMAL EXPERIMENTS: If only certain animals or animal groups are of interest, please list these:

[X] MALE

[X] FEMALE

[X] NORMAL STATE

[ ] CLINICAL RESEARCH *(testing of drugs or technics in humans only)*

[X] DISEASED STATE

[ ] IN VITRO STUDIES *(of animal or human tissues or fluids only)*

[ ] CASE HISTORIES

LANGUAGE RESTRICTIONS:

[X] ACCEPT ALL LANGUAGES

[ ] ACCEPT ONLY ENGLISH

[ ] ACCEPT CERTAIN LANGUAGES ONLY *(please specify)*

AGE GROUPS: If only certain age groups are of interest, please indicate which ones:

Any age group

GEOGRAPHIC RESTRICTIONS: If only certain regions are of interest, please list these:

No geographic restrictions

It is important that the limitations you desire be stated (item 11). There is no purpose in burdening you with experimental studies if you are interested only in the disease as it occurs naturally in humans, or giving you citations to articles in Japanese or Russian when you read only English and French.

12. KNOWN RELEVANT PAPERS: Please carry out a preliminary literature search of your own before submitting this request to MEDLARS, and supply full bibliographic citations below for relevant articles you have found. Wherever possible, they should be journal articles published since January 1966. These citations will be used as a guide in retrieving similar citations related to your needs. They will also be used in a later appraisal of the results of this search. If no relevant papers have been found, please state "none found".

Anderson DO: The effects of air contamination on health. 3.
a. Canad Med Ass J 97:802-6, 23 Sep 67

Baird VC: Effects of atmospheric contamination on cancer mortality in
b. petroleum refinery employees.
J Occup Med 9:415-20, Aug 67

Gross, P, DeTreville RT, Toker EB, et al: Experimental asbestosis. The
c. development of lung cancer in rats with pulmonary deposits of chrysotile asbestos dust. Arch Environ Health (Chicago) 15:343-55, Sep 67

d. Clemo, GR: Some constituents of city smoke.
Tetrahedron 23:2389-93, May 67

e. Abelson PH: Progress toward abatement of air pollution.
Science 160:257, 19 Apr 68

If you used INDEX MEDICUS for your preliminary search please list the subject headings under which you sought citations:
AIR POLLUTION, CARCINOGENS, ASBESTOSIS, NEOPLASM STATISTICS

We ask you to carry out a preliminary literature search in Index Medicus or other sources (item 12) before submitting your request. Providing citations pertinent to your request will enable the search analyst to understand your question better and will clarify the scope of your interests. It will assist the analyst if the reference is correctly cited and includes the full bibliographic data: author(s), journal title, volume number, date of issue and pagination.

13. SEARCH REQUIREMENTS: Please check one of the boxes below to indicate the type of search that you would prefer:

[X] A broad search designed to retrieve as many as possible of the relevant citations, but which might also retrieve many irrelevant citations.

[ ] A narrow search designed to retrieve some only of the relevant citations, but with few accompanying irrelevant citations.

NUMBER OF CITATIONS EXPECTED: Please check the appropriate box to indicate the number of journal articles dealing with the subject of your request that you consider likely to have been published since January 1966.

[ ] 0	[ ] 10 - 50	[ ] 101 - 200
[ ] 1 - 9	[X] 51 - 100	[ ] 201 - 500
		[ ] OVER 500

14. PRINT ON:

[ ] 3" × 5" cards or [X] 8½" × 11" paper

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(9-68)

We need to know (item 13) whether you want as many relevant citations as possible at the expense of having to sift through a fair number of unwanted articles, or whether you prefer a bibliography having as few irrelevant citations as possible even if this means not retrieving some pertinent ones.

As a result of your having performed a preliminary search of your own, you can probably estimate the number of pertinent articles likely to have been published since January 1966. Please give us this estimate by checking the appropriate box.

Your bibliography can be printed on 3" x 5" cards or on continuous 8 1/2" x 11" computer paper (item 14).

NATIONAL LIBRARY OF MEDICINE PUBLICATIONS

The following publications are available at the prices quoted from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

CUMULATED INDEX MEDICUS

Volume 10 (1969), is a cumulation in eight volumes of the approximately 224,000 citations to articles appearing in *Index Medicus* in 1969. Included, in addition to *CIM* Author and Subject Sections, are *Medical Subject Headings, List of Journals Indexed in Index Medicus,* and *Bibliography of Medical Reviews.* Price: $90.50 ($100.00 foreign). Volume 9 (1968) also available; price: $72.25 ($80.55 foreign).

MEDICAL SUBJECT HEADINGS, 1970 Edition

The 1970 edition of *Medical Subject Headings* is published as Part 2 of the January 1970 issue of *Index Medicus.* The approximately 7,400 subject headings in the 1970 *MeSH* are arranged alphabetically, with cross references, and in categorized lists. Available separately, price: $3.00.

LIST OF JOURNALS INDEXED IN INDEX MEDICUS

The 1970 *List of Journals Indexed* contains four listings of journals indexed in *Index Medicus:* title, abbreviation, subject, and geographical. Price $1.25.

ABRIDGED INDEX MEDICUS

A monthly bibliography, based on articles from 100 English-language journals, designed for the needs of the individual practitioner and libraries of small hospitals and clinics. To begin January 1970. Annual subscription price: $12.00 ($15.00 foreign); $1.00 for individual issues.

INDEX MEDICUS

Index Medicus is published monthly as a bibliographic listings of references to current articles from approximately 2,300 of the world's biomedical journals. Each issue contains a subject and name section and a separate Bibliography of Medical Reviews. *Medical Subject Headings* ($3.00) is included as Part 2 of the January issue. Price: $63.00 ($78.75 foreign); single issues $5.00.

MONTHLY BIBLIOGRAPHY OF MEDICAL REVIEWS

The *Monthly BMR* is a series designed to provide quick guidance to the latest reviews in the journal literature of biomedicine. Each monthly issue duplicates the material appearing in the *Bibliography of Medical Reviews* section of the corresponding monthly issue of *Index Medicus.* Price for one year's subscription (twelve monthly issues): $4.50 ($5.75 foreign); single issues $0.40.

NATIONAL MEDICAL AUDIOVISUAL CENTER CATALOG

The *1968 NMAC Catalog* lists audiovisuals available on short-term free loan to health professionals from NLM's Atlanta-based National Medical Audiovisual Center. National Institutes of Health Publication Number 451. 97 pages. Price: $0.75.

FILM REFERENCE GUIDE FOR MEDICINE AND ALLIED SCIENCES

Published annually for the Federal Advisory Council on Medical Training Aids. The 1968 edition contains information on approximately 2,700 films. Public Health Service Publication Number 487, Revised 1968. 386 pages. Price: $2.75. Supplement, 1969. Price: $0.75.

NLM CURRENT CATALOG

Bibliographic listing of citations to publications cataloged by the Library. Issued beginning January 1970 in three forms: (a) monthly (name section only), (b) quarterly (non-cumulating, subject and name sections), and (c) annual cumulation (subject and name sections). Prices: (a) 12 monthly issues—$7.50 ($9.50 foreign); single issues, $0.65; (b) 4 three-month cumulations (quarterlies)—$13.00 ($16.25 foreign); single issues, $3.25; and (c) annual cumulation—$16.25 ($20.35 foreign). [*1969 Annual Cumulation* (available March 1970), price: $14.25 ($17.85 foreign).]

TOXICITY BIBLIOGRAPHY

The quarterly *Toxicity Bibliography* covers the adverse and toxic effects of drugs and chemicals reported in the approximately 2,300 journals indexed for *Index Medicus.* Price: $14.00 per year ($17.50 foreign); single issues $3.50.

NLM CLASSIFICATION

The *National Library of Medicine Classification: A Scheme for the Shelf Arrangement of Books in the Field of Medicine and Its Related Sciences.* Third Edition, 1964, with 1969 Supplementary Pages. Public Health Service Publication Number 1108, Reprinted 1969. Price: $2.75 ($3.45 foreign).

A CATALOG OF SIXTEENTH CENTURY PRINTED BOOKS IN THE NATIONAL LIBRARY OF MEDICINE

Over 4,800 rare sixteenth century printed volumes from NLM's History of Medicine Division collection are listed. Some 1,500 printers and publishers and 188 different printing centers in fourteen European countries are indexed in detail. Casebound. 1967. 698 pages. Price: $5.25.

INTERNATIONAL BIBLIOGRAPHY OF MEDICOLEGAL SERIALS 1736-1967

An annotated listing of serials published on legal medicine and related fields. Includes six indexes (title, editors, publishers and sponsors, subject, geographical, and chronological). 1969. Price: $1.25.

BIBLIOGRAPHY OF THE HISTORY OF MEDICINE

Number 3, 1967, is the third of an annual series of bibliographies on the history of medicine and related sciences, professions, and institutions. Prices: Number 2, 1966 (Public Health Service Publication Number 1540–2) $1.25; Number 3, 1967 (PHS Pub. No. 1540–3) $2.75.

PRINTS RELATING TO DENTISTRY

Includes reproductions of 67 prints illustrating the history of dentistry from the Library's extensive collection of pictures of nonclinical medical interest. Dates of the prints range from the 15th to 20th centuries. Public Health Service Publication Number 1605. 1967. 36 pages. Price: $0.50.

MEDLARS: 1963–1967

Comprehensive description of NLM's Computer system, MEDLARS (Medical Literature Analysis and Retrieval System). 76 pages with illustrations. Public Health Service Publication No. 1823. 1968. Price: $0.75

GUIDE TO MEDLARS SERVICES

Available without charge from NLM. Write to: Office of Public Information, National Library of Medicine, 8600 Rockville Pike, Bethesda, Maryland 20014.

NATIONAL LIBRARY OF MEDICINE RECURRING BIBLIOGRAPHIES

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(1) The *Bibliography on Medical Education* is published monthly in the *Journal of Medical Education* ($15 per year). Cumulations for 1964–65 and 1966 are available from the American Association of Medical Colleges, 2530 Ridge Avenue, Evanston, Illinois 60201, for $2.00 each.

(2) The quarterly *Cerebrovascular Bibliography* is prepared under the auspices of the Joint Council Subcommittee on Cerebrovascular Disease, National Heart Institute, National Institutes of Health, Bethesda, Maryland 20014. Distribution is limited. For information write to the Executive Secretary, Joint Council Subcommittee on Cerebrovascular Disease.

(3) The monthly bibliography, *Fibrinolysis, Thrombolysis, and Blood Clotting*, is distributed by the National Heart Institute. For information write to Dr. James M. Stengle, National Heart Institute, National Institutes of Health, Bethesda, Maryland 20014.

(4) The monthly *Index of Rheumatology* is available from the American Rheumatism Association Section of The Arthritis Foundation, 1212 Avenue of the Americas, New York, New York 10036. Price: $6 per year ($7 foreign); $3.50 to members of the American Rheumatism Association.

(5) The quarterly *Index to Dental Literature* is sold by the American Dental Association, 211 East Chicago Avenue, Chicago, Illinois 60611. Price: $20 for four cumulative issues, (including annual cumulation); $10 for annual cumulation alone.

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(9) The *Bibliography of Surgery of the Hand*, a quarterly, is published and distributed by the American Society for Surgery of the Hand. For information write to John P. Adams, M.D., Chairman, American Society for Surgery of the Hand, 2150 Pennsylvania Avenue, N.W., Washington, D.C. 20037.

(10) The *Anesthesiology Bibliography*, a bimonthly, is published and distributed by the American Society of Anesthesiologists. For information write: Wood Library, Museum of Anesthesiology, American Society of Anesthesiologists, 515 Busse Highway, Park Ridge, Illinois 60068.

(11) The quarterly *Toxicity Bibliography* is published by the National Library of Medicine and distributed by the Superintendent of Document, U.S. Government Printing Office, Washington, D.C. 20402. Price: $14.00 per year ($17.50) foreign); single issues, $3.50.

(12) The monthly *Current Bibliography of Epidemiology* (CuBE) is published by the American Public Health Association. For information write to the Editor, CuBE, American Public Health Association, 1740 Broadway, New York New York 10019.

(13) The *Neurosurgical Biblio-Index*, a quarterly, is published by the American Association of Neurological Surgeons. For information write to the Subscription Manager, *Journal of Neurosurgery*, Suite 1230, 251 East Chicago Avenue, Chicago, Illinois 60611.

(14) The *Cranio-Facial—Cleft Palate Bibliography* is published quarterly by the American Cleft Palate Association. For information write to the Chairman, Nomenclature Committee, Box 3098, Division of Plastic, Maxillofacial and Oral Surgery, Duke University Medical Center, Durham, North Carolina 27706.

(15) The Index of *Investigative Dermatopathology and Dermatology* is published monthly by the Universities Associated for Research and Education in Pathology, Inc. For information write to the UAREP, 9650 Rockville Pike, Bethesda, Maryland 20014.

(16) The *Recurring Bibliography of Hypertension* is published bimonthly by the American Heart Association, Inc. For subscription information write: The American Heart Association, Inc., 44 East 23rd Street, New York, New York 10010.

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